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Camera Artifacts in IUE Spectra

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TABLE OF CONTENTS

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ABSTRACT

This study of emission line mimicking features in the IUE cameras has produced an Atlas of artifacts in high-dispersion images with an accompanying table of prominent artifacts and a table of prominent artifacts in the raw images along with a median image of the sky background for each IUE camera. This study will result in two poster presentations at the January 1994 American Astronomical Society meeting in Washington D. C., a refereed article in the Publications of the Astronomical Society of the Pacific (PASP), and a copy of the final report to R. Oliversen (the Technical Officer), S. Cover (the Contracting Official), and to NASA Publications.

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INTRODUCTION

The analysis of long-exposure IUE data is hampered by cosmic-rays hits and by camera artifacts, which are artificial emission features that are visible at fixed locations in IUE spectra. Cosmic-ray hits in background regions can be detected by inspection of the raw images; hits in the spectral regions can be detected by comparing more than one image of the same target. Camera artifacts could potentially be the source of much confusion for scientists, since they are visible on every exposure of a target that is greater than about one hour. The best way to identify camera artifacts is to use sky-background spectra, since the only "real" feature in these spectra should be geocoronal Lα at 1216 Å in the SWP region.

When we were with the IUE project, we initiated a study of camera artifacts in low-dispersion spectra. We found that the artifacts have been present at the same approximate wavelengths since the beginning of the IUE mission. The artifacts are strong in long exposures because they scale in time-integrated flux with the background level, as a result of camera phosphorescence (see Grady and Imhoff 1985). Plots of averaged sky-background spectra were published (Crenshaw, Bruegman, and Norman 1990) and included in the IUE Data Analysis Center (IUEDAC) software (procedure ARTIFACT) to aid scientists in the identification of artifacts in their low-dispersion spectra.

After we left the IUE project, we received this ADP grant to study artifacts in high-dispersion spectra and in raw images. This work is now complete, a paper on the results is in preparation (Crenshaw et al. 1993), and two poster papers have been prepared on the results for the January 1994 AAS meeting.

The objectives of this program were to identify the locations in raw images that give rise to the artifacts seen in low- and

high-dispersion spectra, and to produce an atlas of high-dispersion sky-background spectra that identify camera artifacts. Identification of the artifacts in raw images could allow the flagging of offensive pixels during image processing, and the production of a high-dispersion atlas will enable the scientist to distinguish between real and artificial spectral features in high-dispersion spectra characterized by long exposure times.

DESCRIPTION OF THE DATA

A. Raw Images

The first effort under this contract was to map the positions of artifacts in raw images. For each camera the following seven raw sky-background images were analyzed.

- List of Images Used

SWP 17680, 17754, 18841, 19434, 19821, 20354, 20661

LWP 10124, 10143, 10374, 10380, 10400, 10545, 10733

LWR 13224, 13426, 13434, 13578, 13663, 13760, 13826

- Data Reduction

To provide reasonable statistics yet keep the computer time short enough to finish the project we used seven images for each camera. Background noise is dependent on many things, eg., exposure time, radiation levels, previous exposure history of the camera. Thus images were chosen that have similar average background Data Number (DN) levels. Also, pixel locations can change with time and temperature. Therefore, the images used were taken within a few years of each other and checked to ensure that individual pixel locations didn't vary from image to image by more than one half pixel.

Next, we normalized the background values for the seven images to allow comparison. An average artifact image was obtained by taking the median value for each pixel location, eliminating values greater than 7σ from the median (the cosmic-ray hits), and recomputing the median at each location to obtain an "average" sky-background image.

A histogram of the background DN values in an image produces a positively skewed Poisson distribution. So we used

the median value of an average image of the seven images to normalize to (actually we normalized each quarter of an image). Once the images were normalized we stacked the seven images and created a median image from the seven images. This eliminated cosmic ray hits and pings and provided a reference image to use to eliminate cosmic ray hits from the individual seven images. Once the hits were removed a new median image was created so that the hits did not influence the median values of pixels in the image. This final median represents a typical long exposure sky background image without cosmic ray hits and can be used to identify artifacts pixel by pixel raw images for each camera.

We used the photon statistics of the cameras to determine the standard deviation based on the median value. Using the photons statistics we can change to DN statistics. According to the IUE camera manual the:

LWP camera has ~ 4 photons per DN,

LWR camera has ~ 3 photons per DN", and

SWP camera has ~ 3 photons per DN".

Let p = the number of photons, then $\sigma_p = \sqrt{p}$. DN = cp where c = ¼ for the LWP camera and ⅓ for the LWR and SWP cameras. So $\sigma_{DN} = c\sigma_p = c\sqrt{p} = c\sqrt{(DN/c)} = \sqrt{c}\sqrt{DN}$. Therefore, for the LWP: $\sigma_{DN} = \frac{1}{2}\sqrt{DN}$, and for the SWP and LWR: $\sigma_{DN} = \sqrt{\frac{1}{3}}\sqrt{DN}$, where σ_{DN} is the standard deviation.

With a median image for each of the three cameras and a way to calculate the standard deviation for each camera using photon statistics we can now identify artifacts in the cameras based on the median value of the pixels in an area (9x9 pixels) around a specific pixel.

We started hunting artifacts assuming that pulling out pixels that were 3 standard deviations above the local background

would produce a reasonable set of artifacts for each camera. However, even with N = 5, we isolated more artifacts than seemed significant. For long exposures there is a large, but different, amount of fixed pattern noise in each camera. Above this fixed pattern background noise artifacts became apparent. The multiple of the standard deviation used for each of the cameras to find significant artifacts was N = (7, 9, and 11) for each camera (SWP, LWR, and LWP) respectively. There were 300-350 artifacts found for each camera at these values for N. Tables of the artifacts found are given in Appendix A.

B. High Dispersion

The second effort under this contract was to produce an atlas of artifacts in high dispersion for all three cameras. To do this, seven images were chosen for each camera and reprocessed as high dispersion images using current IUE SIPS.

- List of Images Used

SWP 17680, 17754, 18841, 19434, 19443, 19821, 20661

LWP 10143, 10374, 10380, 10400, 10545, 10733, 11052

LWR 13224, 13426, 13434, 13578, 13663, 13760, 13826

- Data Reduction

The sky background images for each camera were processed under the old system (IUESIPS) as high-dispersion spectra. We extracted and flux-calibrated the data so that we had seven individual spectra for each order. The orders were separated and looked at individually. For the SWP camera, echelle orders 125 through 66 were studied. For the LWP and LWR cameras, echelle orders 125 through 72 were studied. Because IUE processing software follows the shift of the spectra, the artifacts which are consistent in pixel location did not appear

in the same wavelength position from image to image. Thus, each order of each of the seven images had to be shifted. The spectra were cross-correlated to align the features. Once the artifacts were lined up the cosmic ray hits were flagged by using the error vectors to exclude wavelength regions that were affected by reseaux, hits, or other defects so that they would not appear in the average image. The images were then averaged so that flagged points were not included. A number of artificial emission features were detected.

The table in Appendix B lists the artifacts in each camera by order and relative wavelength position. Also provided in Appendix B are an atlas for each camera showing the characteristic background noise pattern for each order. These can be used to compare against long exposure time high dispersion spectra to determine if the features seen are real or camera artifacts. (Note that the data near the edge of an order are typically much noisier and in some cases can be replaced using another order.)

RESULTS

Camera artifacts were identified as significant patches of emission relative to the surrounding background. Most of the artifacts have widths in the range 2 - 4 pixels (FWHM). The strong artifacts seen in the low-dispersion study can be matched with those found on the raw images, demonstrating that the artifacts are not a by-product of the processing technique. A table of the artifact positions and strengths will be provided to the IUE project.

An atlas of the high-dispersion artifacts has been prepared, and will be published along with the study of raw images.

A. Raw Images

The pixel locations and the relative intensities were determined for 297, 281, and 362 artifacts for the SWP, the LWR, and the LWP cameras, respectively. To identify these strongest artifacts, values greater than $N\sigma$ were chosen, where σ is the standard deviation and where N=7 for the SWP, N=9 for the LWR, and N=11 for the LWP.

The three tables in Appendix A list the position of each selected artifact, the peak intensity of the feature, and the surrounding background value. Included in the list of artifacts found are the features at 1663Å and 1750Å; consistent with earlier findings.

B. High Dispersion

Table 1 on the following page provides a list of the prominent artifacts in the SWP, LWP, and LWR high-dispersion images. The artifact positions are identified first by the echelle order number and then by the relative wavelength where artifacts were found in that order. An atlas of the high-dispersion artifacts is provided in Appendix B.

ARTIFACT ORDER AND RELATIVE WAVELENGTH							
SWP				LWP		LWR	
Order	*Rel. λ*	*Order*	*Rel. λ*	*Order*	*Rel. λ*	*Order*	*Rel. λ*
124	1107	73	1881	93	2483	122	1888
	1118		1882	80	2880	112	2067
119	1155		1884				2074
	1160		1884			107	2167
118	1166	72	1916			106	2172
108	1274	69	2005			100	2303
	1274		2010				2322
	1275		2011			98	2356
	1282	67	2059			94	2450
107	1286		2060			92	2523
	1286					84	2731
106	1299					82	2829
103	1338					80	2900
101	1370					76	3029
98	1407					75	3066
	1413						3083
95	1454						3100
94	1471					72	3194
93	1482						3195
	1483						
	1488						
92	1501						
	1505						
	1505						
90	1537						
89	1549						
	1552						
88	1562						
	1567						
	1567						
	1573						
87	1578						
	1589						
	1593						
	1594						
86	1604						
82	1691						
80	1726						
79	1750						
78	1762						
	1758						
77	1790						
	1796						
76	1810						
	1821						
	1825						

Table 1 Prominent Artifacts In High-Dispersion

SUMMARY

We will be working with the IUEDAC in the near future on a procedure to display the high-dispersion sky-background spectra for comparison with science data processed with the old system.

The results of this study will also be published in a future edition of PASP.

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Appendix A.

Tables of Prominent Artifacts in the Raw Images

The locations of artifacts found in the raw images are listed in the following tables. Provided are the X and Y (line and sample) pixel locations of the peak value of the artifacts, the DN value at the peak, and the median value of the background around the artifact.

Table 1 provides SWP artifact positions and intensities.

Table 2 provides LWR artifact positions and intensities.

Table 3 provides LWP artifact positions and intensities.

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TABLE 1

SWP Artifact Positions and Intensities

X	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*
123	242	101	61	293	334	108	57	379	202	67	39
126	569	244	76	295	221	71	42	379	420	100	66
133	202	95	60	298	315	92	52	386	300	88	49
149	373	106	63	299	217	70	42	386	343	95	57
152	259	87	54	300	462	108	72	386	613	251	64
152	299	93	57	302	423	118	66	393	225	68	40
152	334	95	58	305	499	144	76	397	281	74	46
167	580	117	78	306	364	98	60	398	191	81	39
169	270	92	52	307	269	86	45	403	333	84	51
169	316	98	58	308	576	127	82	406	257	75	44
179	220	90	56	309	214	71	43	407	234	75	41
181	244	91	53	309	241	78	43	407	367	89	58
187	508	117	76	309	475	121	73	408	346	106	56
191	169	83	51	310	277	73	45	410	434	121	66
191	286	88	54	312	338	108	55	411	274	73	43
194	348	97	62	313	210	77	44	411	430	120	67
206	221	100	57	313	241	73	45	412	338	83	52
209	224	87	54	313	304	91	52	413	244	75	42
214	215	81	51	315	419	110	67	414	254	70	42
226	216	95	50	317	226	70	43	414	464	118	67
227	200	86	48	319	490	123	73	415	192	75	44
228	272	86	51	320	277	75	47	418	251	75	42
230	377	94	62	322	201	71	43	422	176	65	37
231	286	108	54	322	346	101	58	422	449	117	65
240	190	73	45	323	482	115	73	425	270	87	45
241	151	76	45	324	206	69	42	428	260	71	42
245	178	75	45	324	341	106	57	428	264	76	42
245	194	73	44	325	182	68	41	431	251	80	43
254	210	75	44	325	264	83	48	431	372	92	56
254	473	125	73	326	237	70	43	431	535	103	66
257	329	96	55	326	458	130	72	432	276	76	48
261	641	118	71	335	252	76	46	434	188	66	38
264	198	67	41	339	224	75	42	435	177	70	36
264	295	82	50	339	300	96	52	435	184	61	36
265	230	74	43	344	292	109	50	436	294	74	47
267	123	69	41	347	486	120	72	437	102	62	37
267	150	69	39	348	305	82	51	437	316	81	49
269	232	71	42	349	510	113	74	438	512	111	68
270	182	65	40	354	495	108	72	439	234	71	41
270	261	77	44	355	176	63	37	439	399	106	58
270	282	75	46	358	338	93	55	440	142	58	33
272	131	62	37	359	270	72	44	440	226	65	39
278	450	132	77	364	249	72	44	442	221	67	39
281	517	139	81	364	317	96	54	443	156	60	35
284	412	106	67	367	195	78	40	443	278	73	45
286	386	107	62	367	392	115	63	444	266	70	44
287	453	111	74	368	216	72	41	445	551	98	62
288	453	109	74	373	148	61	35	447	220	70	40
291	341	99	58	374	230	68	41	447	439	100	61
292	547	127	87	378	592	113	70	449	442	124	63

TABLE 1
(Continued)

X	Y	Peak	Back	X	Y	Peak	Back	X	Y	Peak	Back
451	232	70	40	496	206	67	38	540	203	68	40
452	277	75	43	496	250	68	40	541	256	79	45
453	198	62	37	497	155	63	34	542	154	69	40
453	220	76	41	497	218	67	39	542	260	73	45
453	270	71	44	497	559	114	60	542	279	73	46
453	445	100	64	500	125	58	33	544	278	80	44
454	301	78	47	501	66	68	41	544	309	85	47
458	169	57	33	502	289	72	44	545	386	83	51
458	252	70	43	502	438	98	58	546	293	74	45
459	333	88	51	503	405	87	56	546	350	93	52
460	229	71	41	504	302	77	46	547	199	74	41
461	274	84	43	507	288	70	43	548	125	67	40
462	185	66	38	509	254	71	43	548	304	80	48
462	207	69	38	509	277	71	43	549	144	71	40
462	244	72	43	509	461	139	58	549	160	69	40
467	377	85	54	510	215	66	40	550	274	74	45
470	273	78	43	511	509	117	66	550	320	78	49
471	87	61	36	512	330	79	49	551	294	79	48
471	120	57	33	513	202	71	40	553	175	67	41
472	149	56	32	513	258	70	42	554	311	77	49
472	277	74	44	519	209	66	40	554	471	91	54
473	120	58	33	519	216	73	39	555	269	80	46
473	311	76	47	519	427	87	55	555	379	81	51
473	524	96	62	520	646	73	45	557	189	68	41
474	183	63	35	521	170	65	39	557	246	70	44
475	235	74	39	522	226	69	40	558	259	73	44
476	240	76	43	522	255	83	43	558	503	91	58
476	586	89	58	522	399	247	55	561	189	74	41
477	256	66	40	523	135	62	37	562	167	79	40
478	246	69	41	526	123	79	38	565	181	71	42
478	303	79	47	527	220	80	42	565	295	89	47
479	290	76	47	527	294	76	46	565	555	98	53
484	234	80	40	527	563	92	59	566	135	69	42
484	316	81	47	528	356	83	51	568	487	83	48
487	341	80	50	528	437	86	55	569	235	73	44
487	523	101	66	529	96	91	44	573	168	73	42
488	190	74	36	530	95	73	45	574	280	73	45
488	333	79	48	530	174	66	40	576	299	78	45
488	394	91	55	530	358	83	51	576	375	81	48
488	482	95	58	532	261	76	43	579	544	94	46
490	146	64	32	533	199	68	38	592	232	79	46
490	237	66	39	534	179	69	42	597	597	68	41
491	367	93	53	534	181	70	41	598	544	82	47
491	542	98	65	534	327	81	50	599	263	70	43
492	329	77	48	535	214	69	42	608	229	73	45
493	288	79	44	537	235	70	40	609	404	79	48
493	349	79	49	537	291	74	44	625	378	74	46
494	97	80	38	538	203	72	40	638	489	71	42
494	575	92	59	538	288	70	43	674	449	74	44
495	404	86	56	539	297	78	47				

TABLE 2
LWR Artifact Positions and Intensities

X	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*
130	474	168	91	376	619	119	73	417	334	127	74
139	433	141	89	376	752	85	12	418	347	130	74
153	172	151	93	379	222	98	57	421	187	102	59
179	91	56	24	379	230	104	62	422	251	104	61
179	95	68	18	379	298	113	68	422	325	115	70
179	427	149	89	380	420	163	89	422	406	125	75
199	169	254	91	381	362	134	84	423	247	125	60
200	428	161	91	382	216	102	59	423	289	106	58
203	352	170	90	383	263	108	63	423	381	127	76
213	510	143	89	384	296	109	66	425	432	120	70
232	353	152	87	384	412	260	88	426	254	111	63
236	560	134	83	386	237	105	58	427	337	128	73
269	66	254	62	386	316	134	77	429	169	98	57
270	130	130	75	386	336	127	79	429	342	120	72
274	220	121	73	387	277	104	62	432	366	143	72
278	503	148	87	388	212	101	58	433	302	147	62
284	538	128	79	388	419	143	89	434	343	117	67
290	125	182	69	389	365	140	86	435	464	118	69
306	532	191	79	389	377	153	87	436	283	101	59
308	652	123	73	389	396	139	89	436	354	132	69
313	595	151	76	389	579	170	78	439	254	109	61
316	332	146	78	390	591	127	79	439	275	97	56
322	255	250	65	391	207	247	58	440	241	104	58
325	214	219	66	393	309	124	70	440	306	103	61
330	679	199	64	395	219	128	62	440	440	112	69
331	337	127	78	396	211	101	60	441	207	109	58
331	353	138	83	397	292	108	65	441	246	141	69
335	296	116	71	397	328	165	74	442	238	119	60
336	206	110	63	397	375	144	88	443	211	100	59
355	317	180	79	399	283	120	62	444	202	98	57
357	210	146	64	399	302	119	67	444	254	110	61
357	361	135	86	400	318	121	74	446	671	113	66
357	410	157	92	400	537	121	76	447	159	103	57
358	294	136	67	402	394	155	88	449	196	103	57
359	263	102	61	402	438	129	76	449	281	111	58
359	347	137	85	402	601	158	84	452	178	100	59
361	284	113	66	404	326	130	73	452	231	104	59
361	417	151	92	405	349	130	79	454	277	105	58
362	346	129	82	407	361	137	80	454	491	117	68
363	163	134	59	408	405	132	82	455	194	102	58
364	318	128	79	410	302	112	65	455	381	113	62
366	305	137	72	410	380	135	80	457	592	129	77
366	377	138	89	411	494	123	73	458	232	97	57
368	174	234	58	413	331	122	73	459	352	103	62
369	314	129	75	413	382	137	80	459	362	100	59
371	335	141	83	415	369	135	80	459	452	110	67
372	325	128	80	416	379	137	79	460	235	100	57
372	510	166	82	417	167	101	59	460	277	106	60
374	356	139	85	417	318	117	71	462	162	99	57

TABLE 2
(Continued)

X	Y	Peak	Back	X	Y	Peak	Back	X	Y	Peak	Back
462	162	99	57	489	222	97	52	521	357	105	59
462	285	104	57	489	369	104	59	521	439	110	63
462	594	126	76	490	408	104	61	522	132	102	60
463	186	103	58	491	387	106	60	522	410	111	57
463	199	115	58	492	171	102	56	525	197	111	58
463	432	108	64	493	319	104	60	525	477	104	60
464	306	101	58	493	532	110	67	525	599	116	71
464	314	100	58	494	220	89	51	526	224	98	55
465	237	104	59	495	215	94	54	527	247	107	58
466	241	109	57	495	336	99	57	527	335	106	60
466	353	103	59	496	116	107	60	527	390	102	59
468	289	97	56	497	291	109	57	527	416	113	62
469	155	106	58	498	168	212	62	528	219	107	59
469	274	97	56	498	191	99	57	528	451	99	59
469	400	106	62	500	279	96	56	529	476	132	62
470	321	109	59	500	377	99	58	535	303	111	57
471	269	102	58	501	425	110	62	538	124	105	62
472	255	106	59	502	416	135	60	539	285	103	57
473	225	102	56	503	141	105	62	539	420	126	62
473	375	101	58	503	271	100	55	541	302	102	58
474	169	109	56	503	279	97	57	541	522	132	63
474	328	109	58	503	312	103	61	544	331	101	58
474	480	106	64	504	267	101	56	544	518	236	61
475	218	123	56	504	356	107	60	547	423	114	61
475	279	99	58	505	243	95	56	549	323	119	58
476	116	109	61	505	273	105	56	550	130	102	60
476	201	107	57	505	461	110	64	557	470	102	59
478	243	118	60	506	256	109	59	564	273	97	56
478	434	146	63	506	324	103	61	564	518	107	62
479	490	114	67	506	485	105	61	565	300	99	58
480	128	99	58	508	260	102	58	569	539	112	61
480	560	131	71	508	329	103	59	574	433	101	57
481	172	97	57	508	494	105	63	574	486	123	60
482	348	153	59	509	146	113	64	580	492	92	53
482	490	118	69	510	229	100	56	584	553	107	57
484	377	112	58	510	446	106	63	587	455	129	58
485	155	104	59	513	433	107	62	592	544	108	55
485	270	115	55	513	557	121	70	597	442	105	56
486	264	96	56	514	311	104	58	605	254	98	58
487	137	118	56	515	259	101	56	609	177	249	61
487	417	102	60	515	275	101	57	611	411	94	51
487	655	124	66	515	338	106	62	612	513	85	49
488	122	105	59	516	288	103	57	623	364	95	51
488	209	100	55	516	330	104	61	629	530	87	47
489	107	102	61	520	186	105	58				

TABLE 3

LWP Artifact Positions and Intensities

X	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*
32	442	57	20	473	234	113	56	499	214	107	61
35	455	93	20	474	188	100	57	499	553	148	93
39	311	50	23	474	253	112	60	500	494	154	83
59	252	53	24	474	307	113	64	501	141	103	60
188	651	126	51	475	456	149	88	501	216	114	61
317	205	116	58	476	157	106	59	501	540	184	91
390	364	151	92	476	201	107	57	502	230	107	61
412	310	119	69	477	199	102	57	503	387	134	76
413	316	126	73	477	302	115	64	504	352	118	71
418	314	122	74	478	274	114	62	505	158	115	64
420	449	157	101	479	207	121	60	505	217	121	61
422	385	158	94	480	248	100	56	505	223	113	62
423	344	134	83	480	266	103	59	505	392	130	76
424	309	112	66	480	380	129	77	505	563	148	93
426	189	102	57	480	469	139	86	506	194	112	63
432	240	118	59	482	273	108	58	507	129	117	65
444	276	108	62	482	309	115	67	507	179	117	65
446	293	108	64	483	271	109	58	507	199	111	60
446	392	149	92	483	416	138	83	507	214	109	61
447	197	124	54	484	231	115	58	507	244	110	62
448	213	104	56	484	246	104	57	508	357	127	69
448	285	110	64	484	284	106	61	508	334	113	67
449	230	107	58	484	367	126	74	509	198	124	62
450	317	120	71	485	266	105	59	509	203	114	61
452	179	102	56	485	327	124	68	509	313	119	66
453	298	117	68	486	254	103	59	509	374	118	71
455	322	123	71	487	226	106	58	510	153	111	64
456	196	107	57	487	535	155	93	510	253	110	63
458	224	103	59	488	273	100	57	510	303	126	66
460	128	102	57	489	190	100	58	511	248	120	63
461	264	108	59	489	268	115	62	511	308	115	66
462	247	110	60	489	373	124	71	511	416	134	76
462	262	107	57	490	98	109	64	512	139	119	65
462	340	128	74	490	122	106	61	512	283	109	61
462	437	140	85	490	175	118	58	514	195	114	63
463	169	95	54	490	219	104	57	514	201	112	60
465	226	103	60	490	355	120	69	514	329	114	67
465	326	126	67	491	272	110	58	515	213	112	64
466	222	110	58	492	209	101	56	515	297	117	67
466	230	118	61	493	150	108	58	515	301	123	65
467	313	115	69	493	216	104	57	516	226	128	66
468	442	150	88	493	318	117	68	516	250	107	58
469	287	118	64	493	360	117	69	516	274	120	62
469	299	123	67	494	136	100	57	516	320	122	67
470	166	101	56	494	439	148	82	517	170	108	64
470	296	113	67	495	242	128	61	517	476	135	81
471	216	101	57	497	213	101	58	517	502	146	84
471	274	103	60	497	402	127	77	518	227	118	65
471	290	108	63	498	252	107	62	518	390	144	76
472	382	135	79	498	329	157	68	519	350	123	74

TABLE 3
(Continued)

X	Y	Peak	Back	X	Y	Peak	Back	X	Y	Peak	Back
520	262	114	62	536	328	116	68	557	135	130	76
520	327	116	68	537	110	126	78	557	234	114	68
521	276	124	63	537	398	130	78	557	283	118	68
522	155	114	67	538	166	124	75	557	315	122	72
522	248	107	62	538	168	125	70	557	452	130	78
523	101	255	79	538	186	130	73	558	132	132	81
523	173	112	67	538	216	132	71	558	248	131	71
523	204	119	65	538	300	117	67	558	269	122	68
523	215	139	68	539	148	121	71	559	123	140	84
523	224	110	62	539	197	115	69	559	135	142	76
523	378	125	73	539	312	122	69	559	250	127	72
523	424	131	79	539	328	124	68	559	261	131	70
524	165	137	67	539	391	129	75	559	272	117	70
525	193	115	66	540	376	129	70	559	285	134	69
525	211	116	68	540	606	169	88	560	146	134	78
525	437	129	79	541	184	131	74	560	177	140	79
526	205	114	67	541	217	129	73	562	482	134	77
526	395	123	74	542	378	122	71	563	149	136	79
527	137	129	71	543	196	121	74	563	238	116	69
527	532	144	89	543	234	126	70	564	123	137	82
528	175	118	68	544	204	123	72	564	198	134	77
528	189	119	68	544	382	139	74	564	253	124	76
528	230	112	66	545	172	126	76	566	242	126	71
528	518	140	87	545	271	116	67	566	363	125	74
529	202	114	68	545	318	127	72	566	377	127	75
529	253	119	67	545	536	147	89	567	185	145	83
529	358	120	72	546	195	133	74	567	341	132	74
530	163	134	70	546	210	125	73	568	147	140	82
530	251	159	65	546	416	126	76	568	153	143	82
530	274	116	65	546	470	132	82	568	159	140	80
531	267	107	62	549	156	128	76	568	174	136	81
531	288	122	65	549	273	116	67	568	197	130	78
532	126	119	72	550	267	128	68	568	208	135	78
532	160	137	73	550	410	139	76	568	247	124	75
532	238	111	64	551	277	131	68	568	282	116	68
532	293	123	68	551	297	119	71	569	151	137	82
532	313	124	71	551	391	135	74	569	193	157	79
533	173	120	71	552	291	119	67	569	251	126	74
533	201	113	67	552	358	119	68	569	547	137	83
533	296	120	69	553	276	115	69	571	307	120	73
533	305	125	69	553	289	118	69	572	203	134	79
533	347	123	72	553	300	124	71	572	211	131	76
534	293	118	68	553	348	125	72	573	208	127	77
534	387	133	77	554	405	136	77	573	219	129	76
535	299	121	68	555	142	130	77	573	526	143	84
535	330	129	71	555	192	128	79	574	500	128	79
536	165	130	76	555	227	119	70	576	118	150	90
536	167	133	72	556	161	153	79	576	175	146	86
536	177	124	75	556	222	127	72	576	211	138	77
536	266	137	67	556	334	124	73	576	444	130	78

TABLE 3
(Continued)

X	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*	*X*	*Y*	*Peak*	*Back*
577	296	133	73	585	242	131	76	605	520	129	77
577	400	134	74	586	183	141	80	605	595	121	73
578	110	149	95	586	508	131	79	606	221	138	86
579	119	144	90	587	148	136	84	606	261	128	78
579	292	139	70	587	209	136	81	607	405	130	75
579	522	136	81	588	178	140	85	608	250	133	79
580	344	121	73	588	245	129	77	609	352	123	73
580	472	126	77	588	285	128	73	611	215	145	87
581	192	153	85	588	364	127	74	613	251	136	80
581	468	138	77	588	481	130	77	614	543	129	78
581	515	130	80	591	203	142	83	616	218	135	82
581	535	138	85	592	227	144	85	617	259	140	80
582	149	142	84	592	290	135	75	621	275	134	79
582	214	138	83	593	299	124	73	622	229	138	82
582	232	137	81	594	319	124	75	625	489	119	71
582	291	123	75	597	198	137	83	625	517	127	73
582	484	124	74	598	468	149	76	627	520	121	73
583	175	146	84	601	290	149	76	637	600	107	61
583	260	134	72	601	316	128	76	652	463	124	75
583	336	136	73	602	358	124	75	675	551	124	63
584	270	147	71	603	258	128	78				

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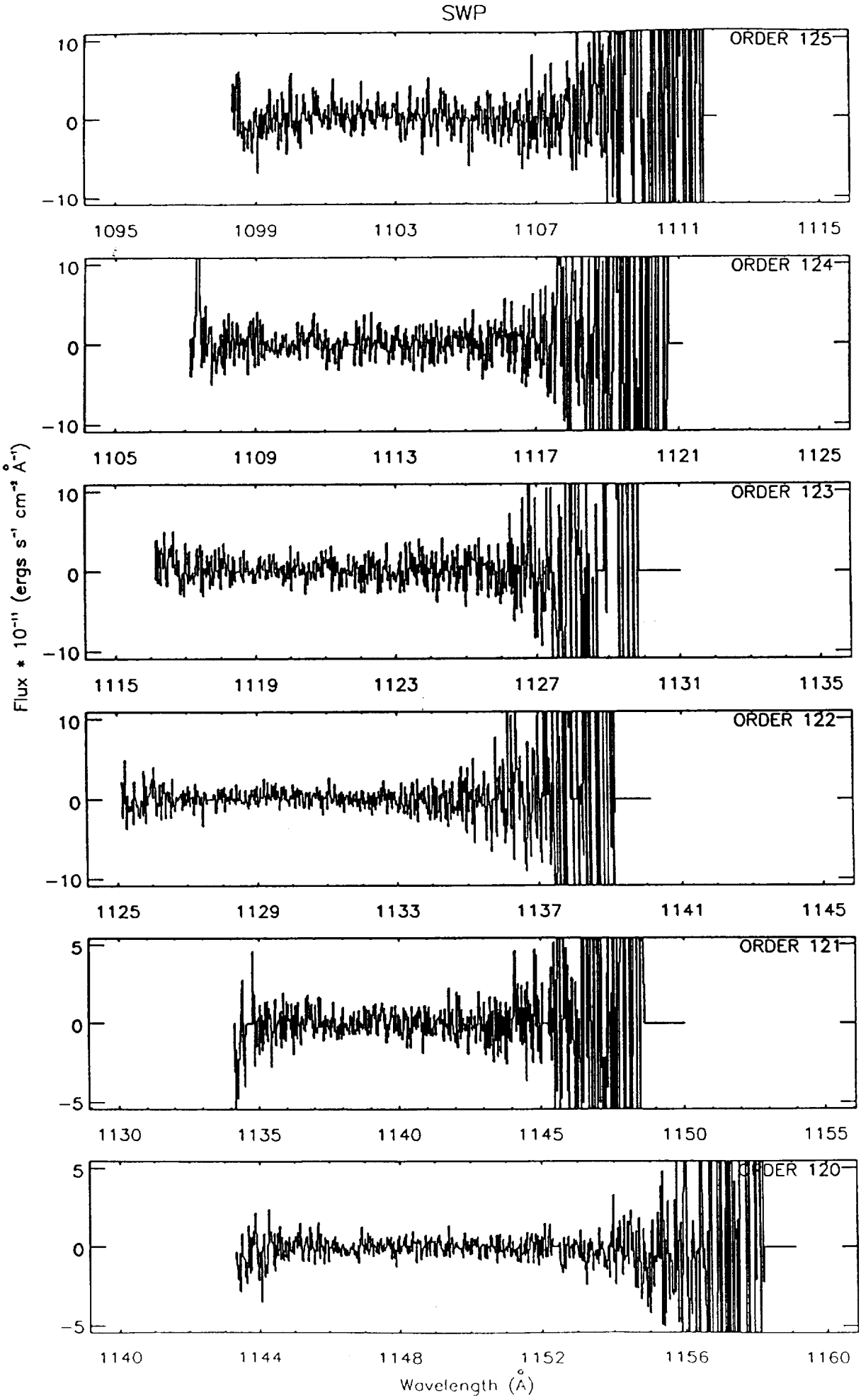
Appendix B.

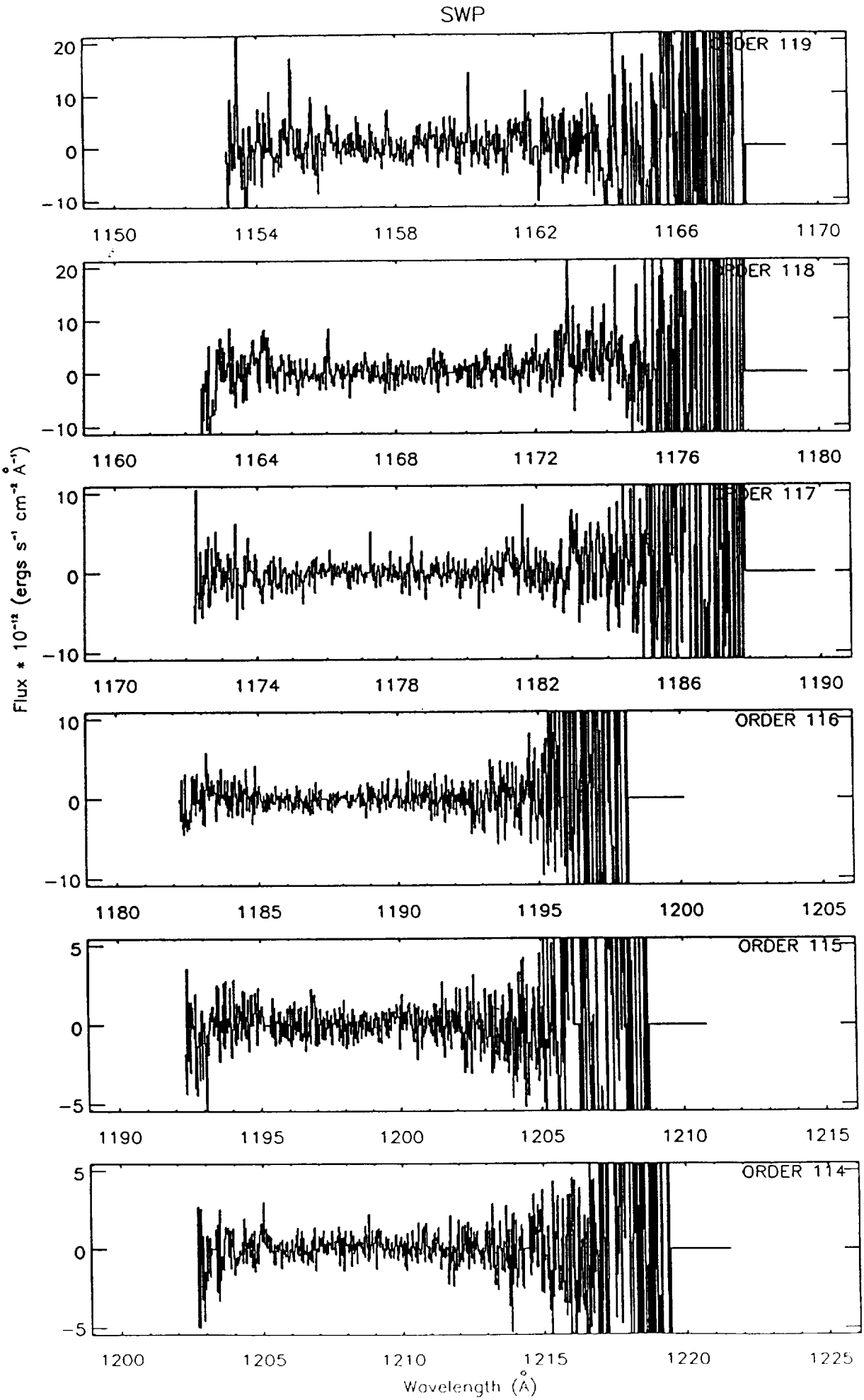
Atlas of High Dispersion Artifacts

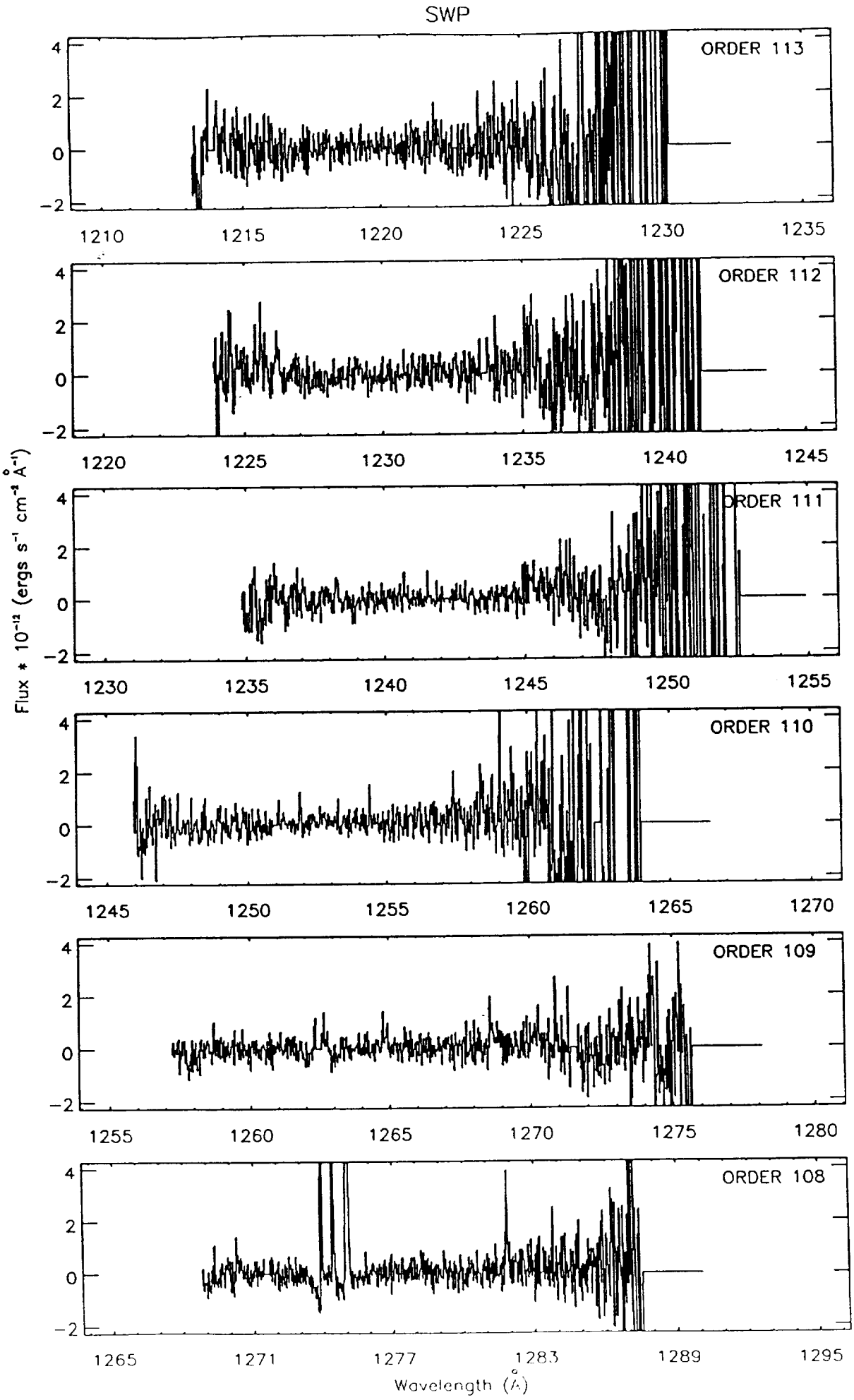
The atlas consists of a plot of the flux for each echelle order of each IUE camera (SWP, LWR, and LWP). The flux units for each plot on a page are listed on the left center of each page. The wavelength is given in Angstroms at the bottom of each plot. The order number is provided in the upper right corner of each plot. Prominent artifacts are listed in Table 1 on page 9.

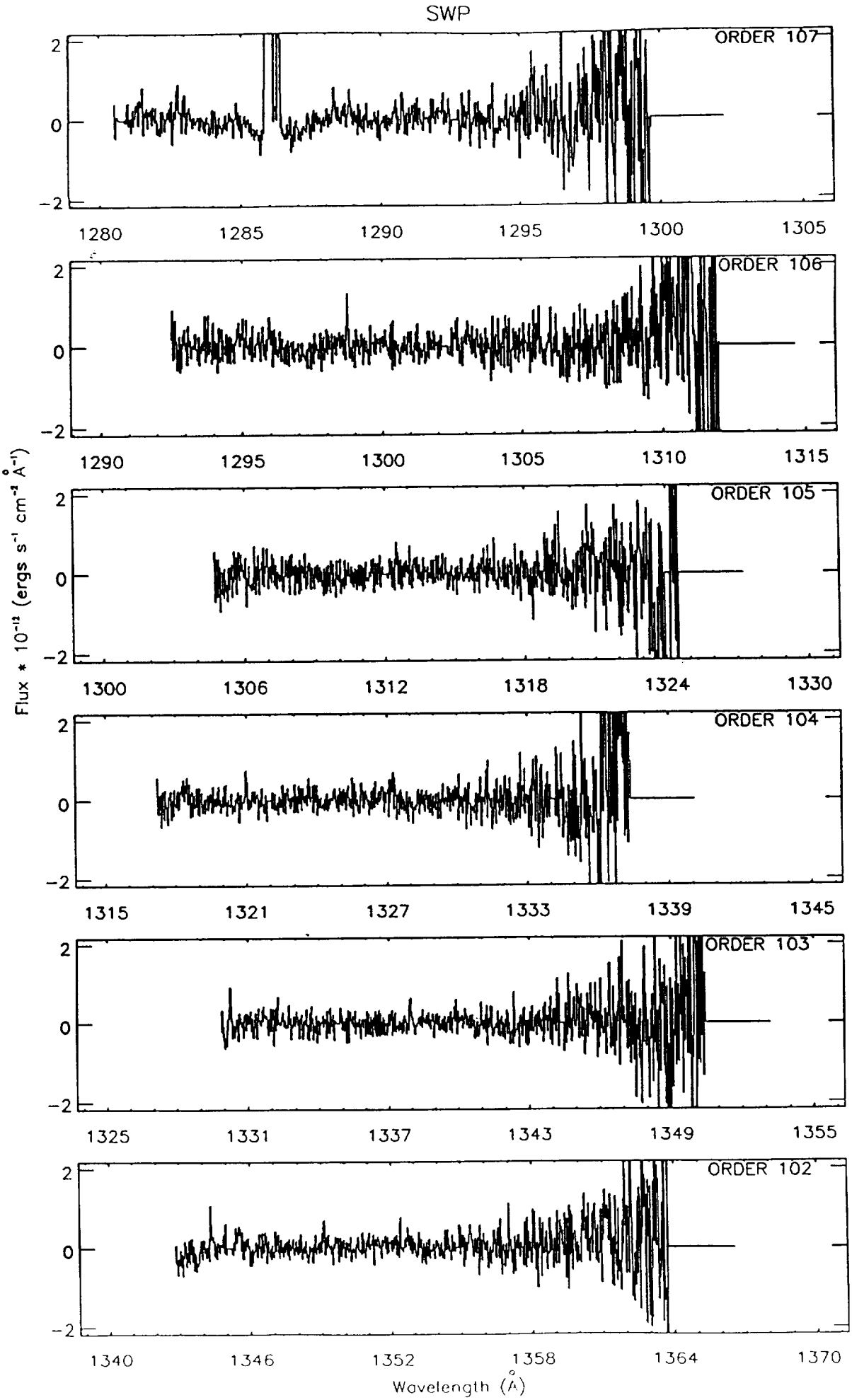
The remainder of Appendix B is single side copied.

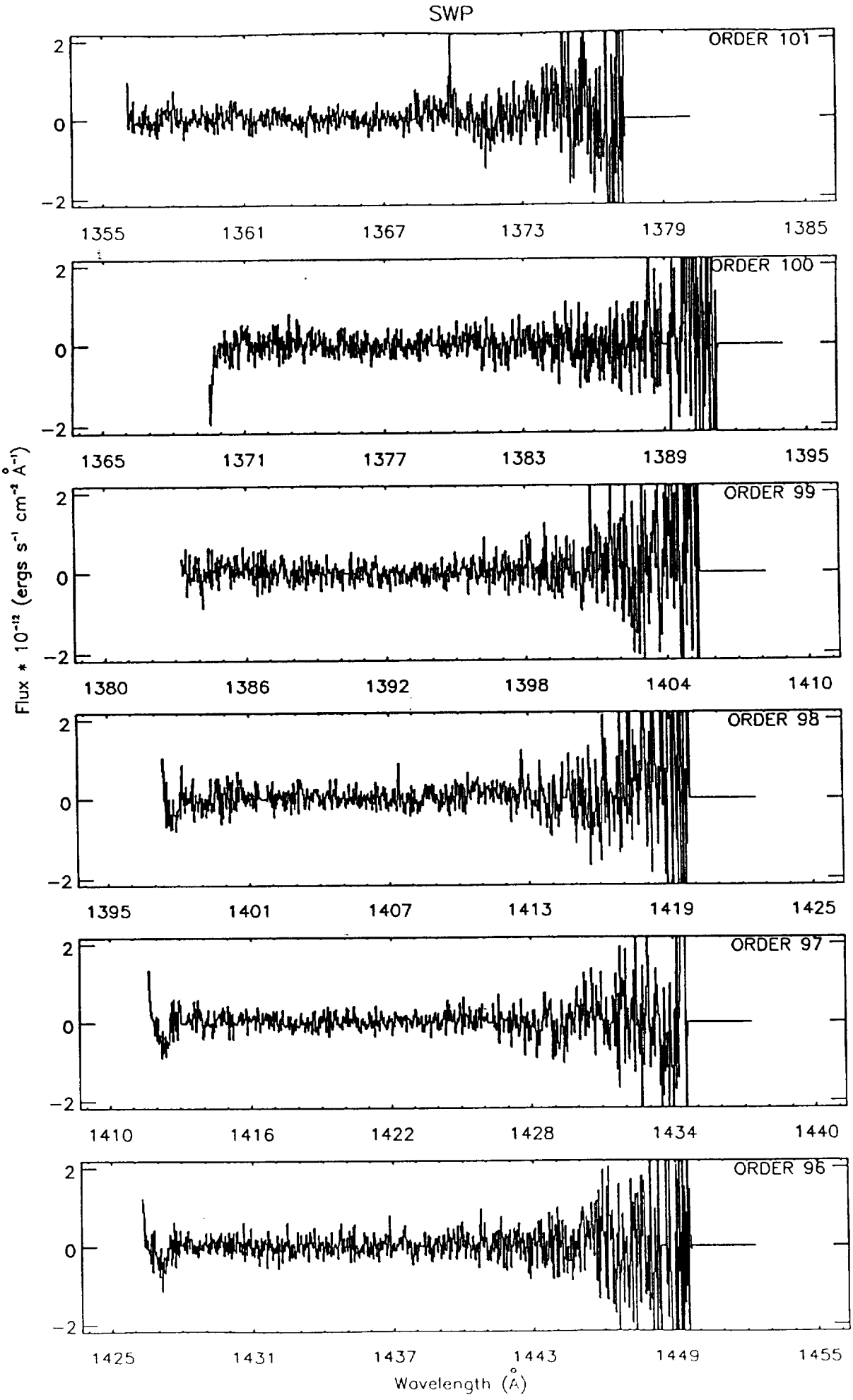
SWP

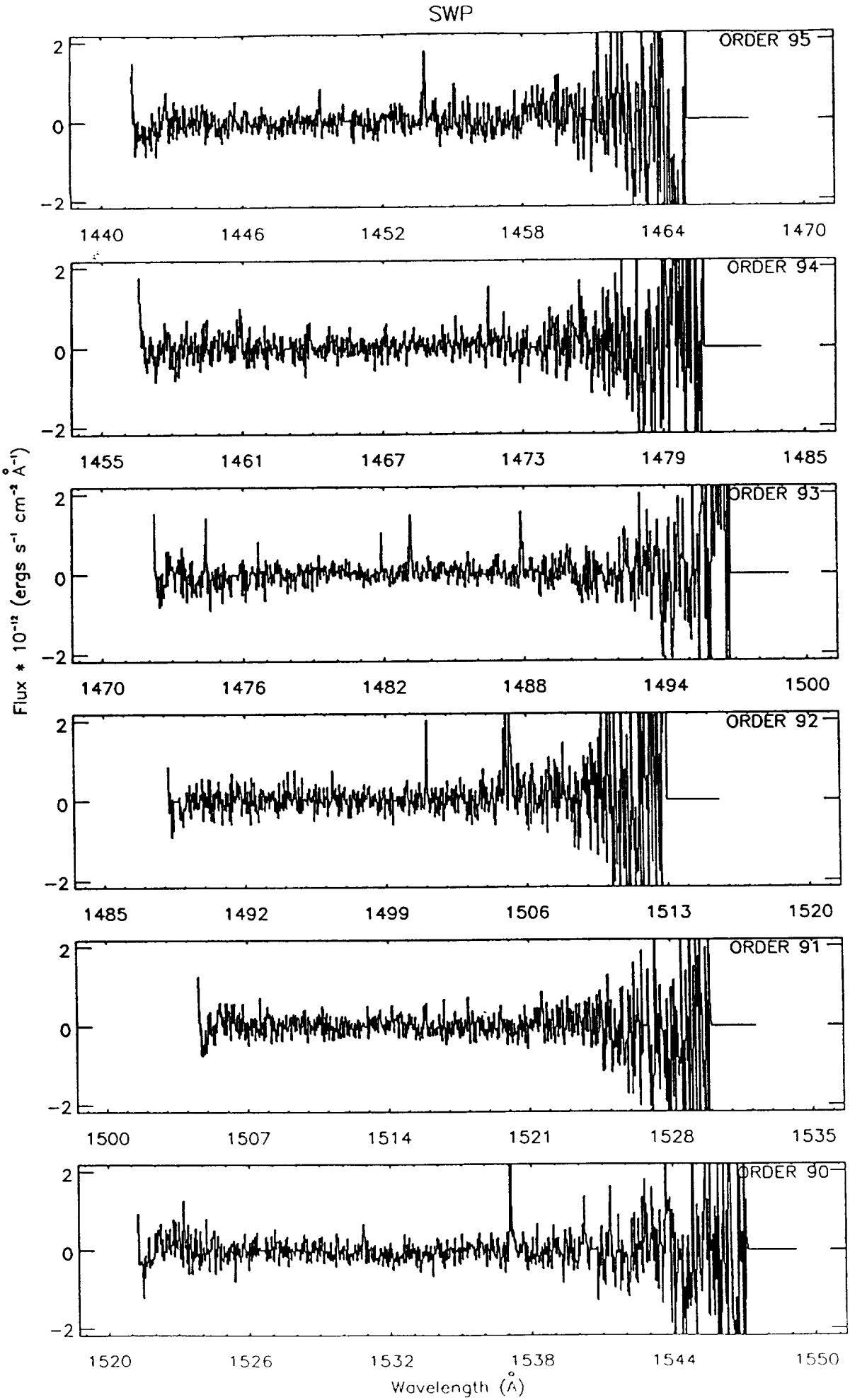

SWP
ORDER 125
ORDER 124
ORDER 123
ORDER 122
ORDER 121
ORDER 120
Flux * 10⁻¹¹ (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

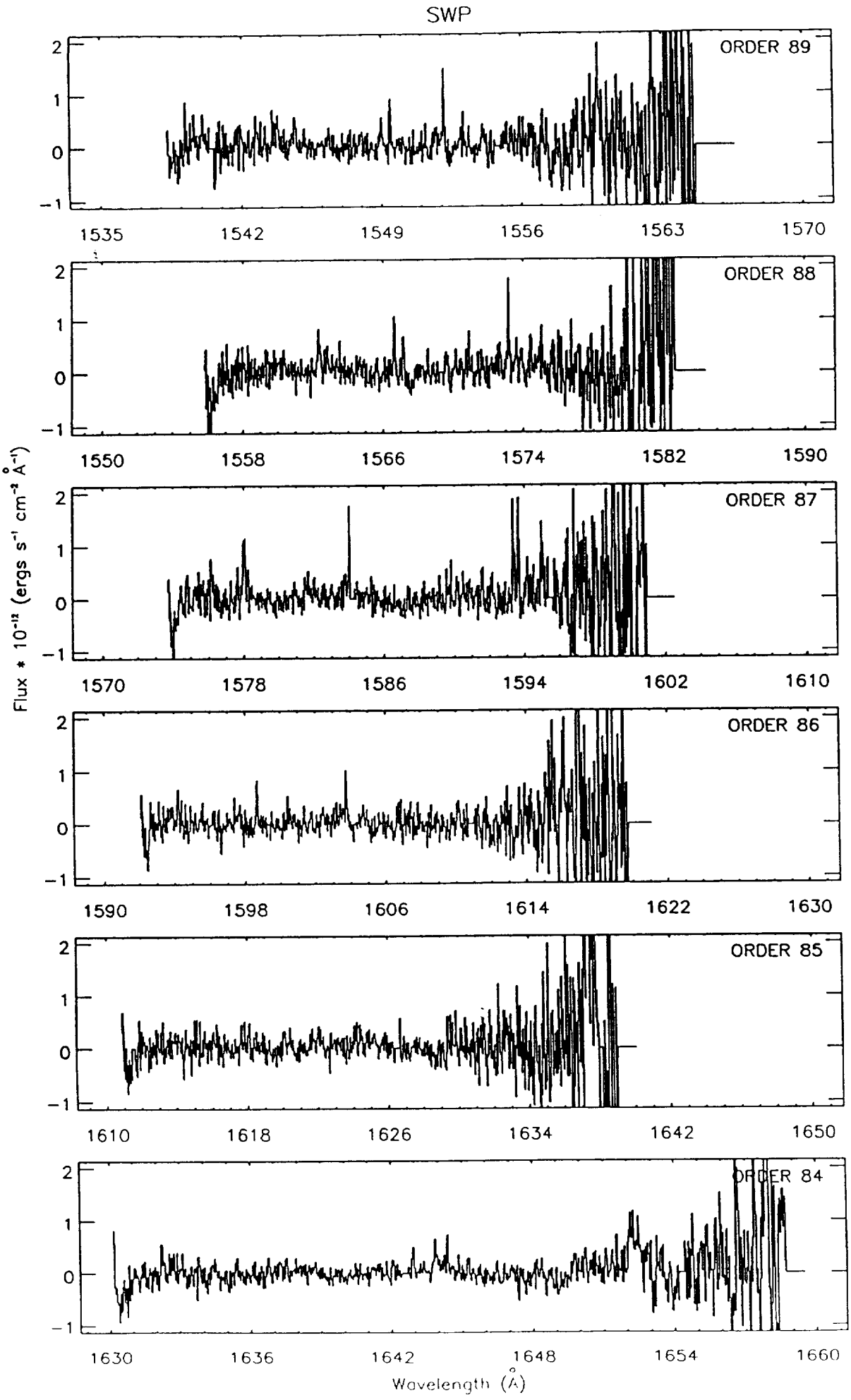

SWP
ORDER 119
ORDER 118
ORDER 117
ORDER 116
ORDER 115
ORDER 114
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

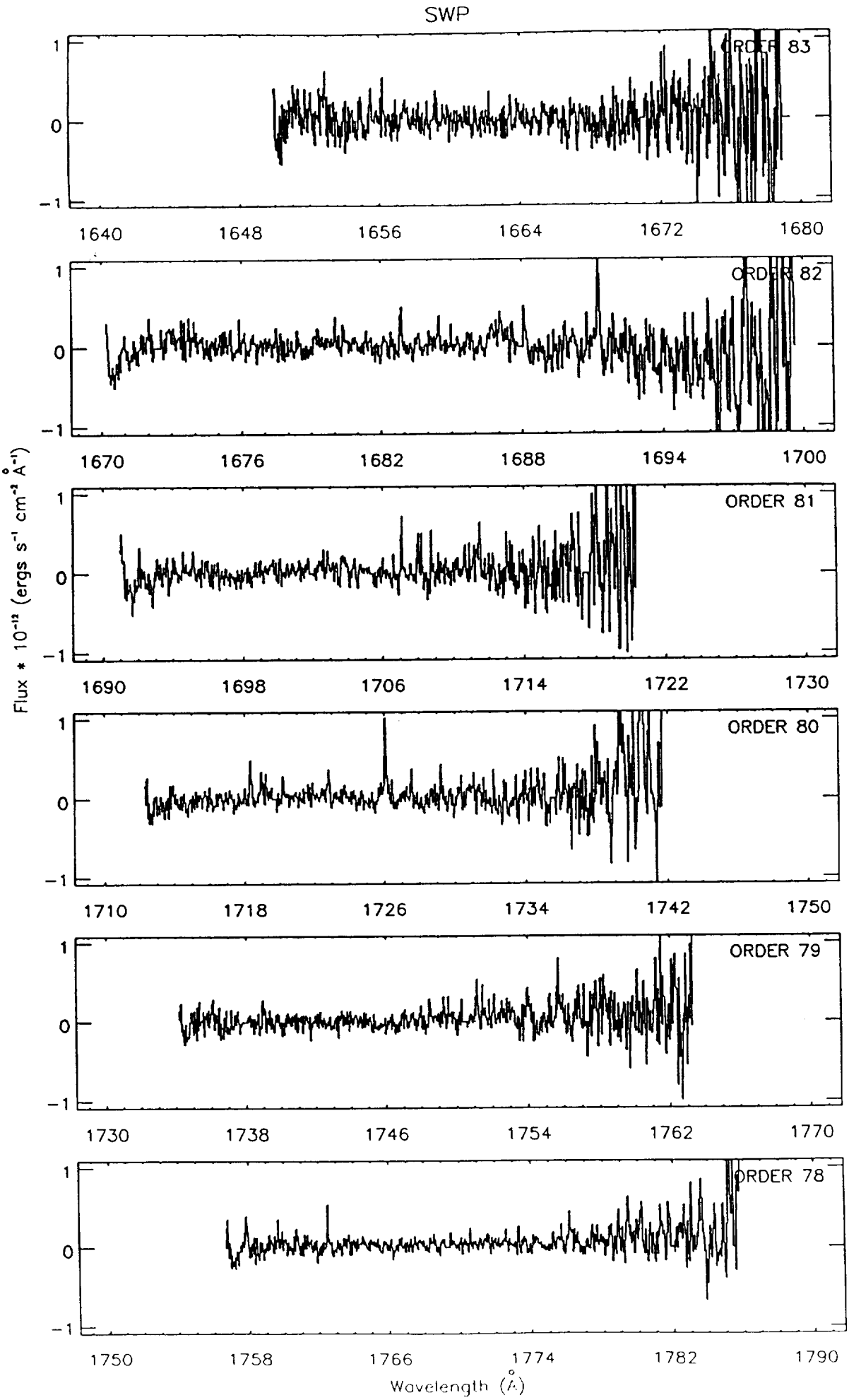

SWP
ORDER 113
ORDER 112
ORDER 111
ORDER 110
ORDER 109
ORDER 108
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

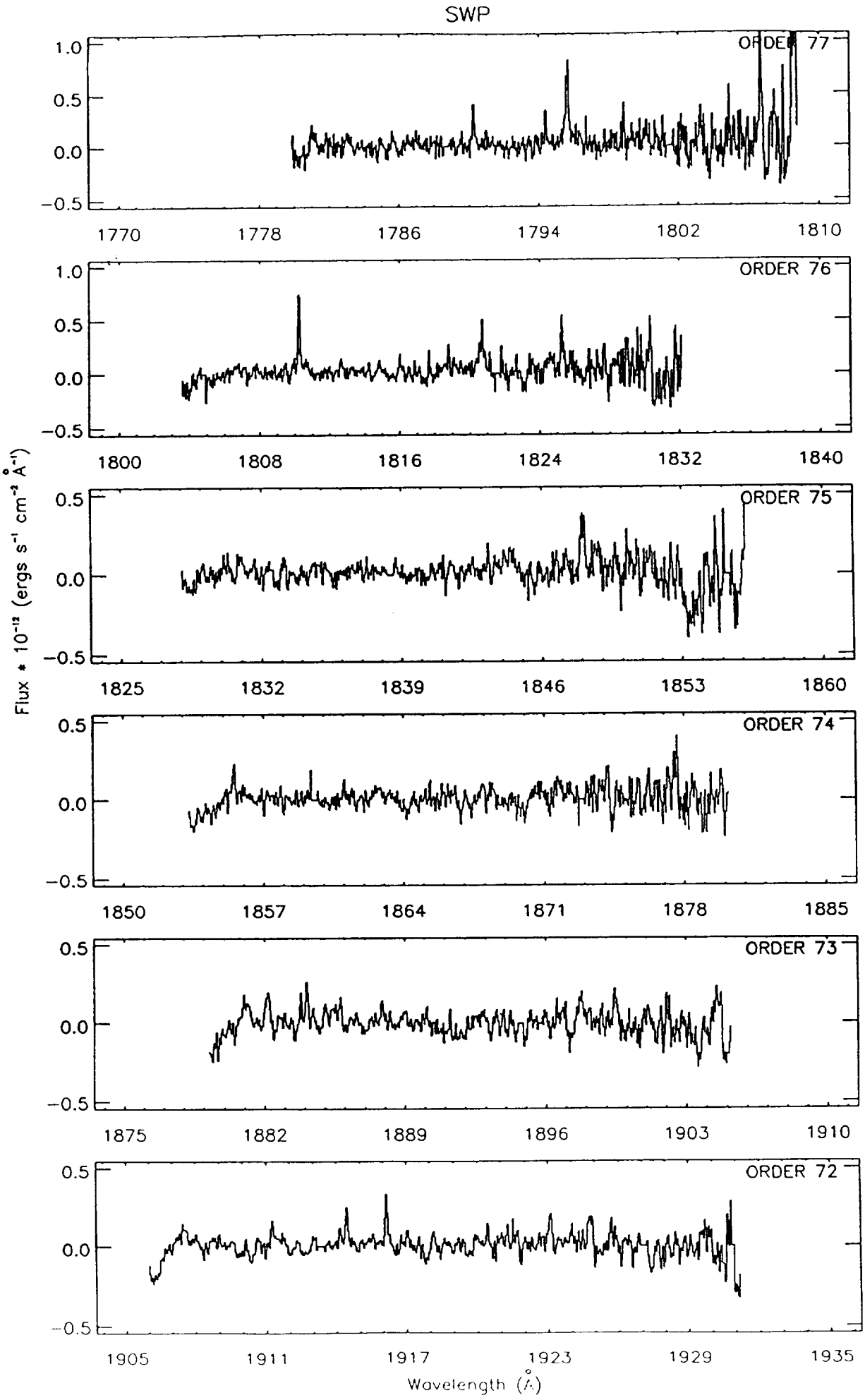

SWP
ORDER 107
ORDER 106
ORDER 105
ORDER 104
ORDER 103
ORDER 102
Flux * 10^-12 (ergs s^-1 cm^-2 Å^-1)
Wavelength (Å)

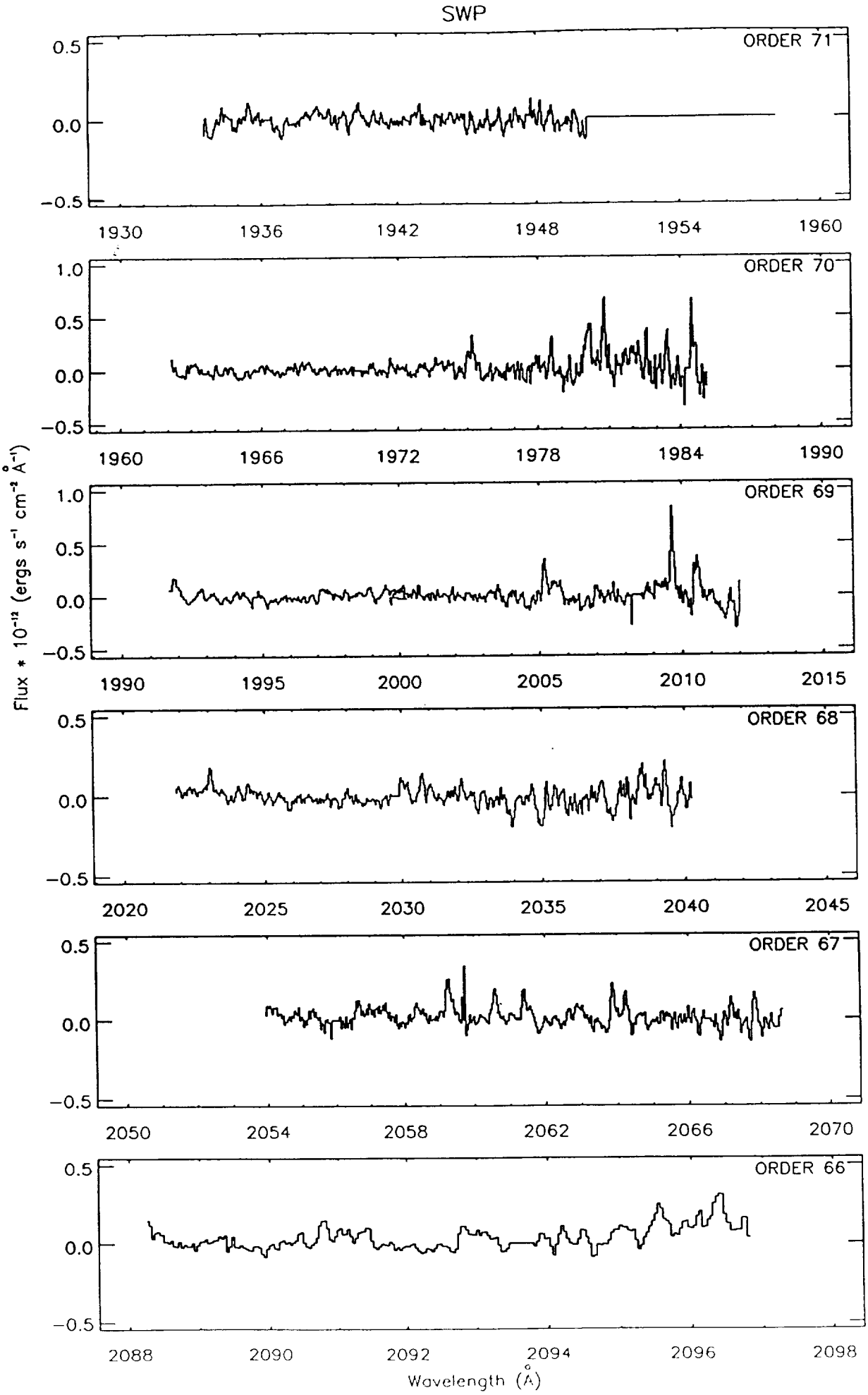

SWP
ORDER 101
ORDER 100
ORDER 99
ORDER 98
ORDER 97
ORDER 96
2
0
−2
1355
1361
1367
1373
1379
1385
1365
1371
1377
1383
1389
1395
1380
1386
1392
1398
1404
1410
1395
1401
1407
1413
1419
1425
1410
1416
1422
1428
1434
1440
1425
1431
1437
1443
1449
1455
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


SWP
ORDER 95
ORDER 94
ORDER 93
ORDER 92
ORDER 91
ORDER 90
2
0
−2
1440
1446
1452
1458
1464
1470
1455
1461
1467
1473
1479
1485
1470
1476
1482
1488
1494
1500
1485
1492
1499
1506
1513
1520
1500
1507
1514
1521
1528
1535
1520
1526
1532
1538
1544
1550
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

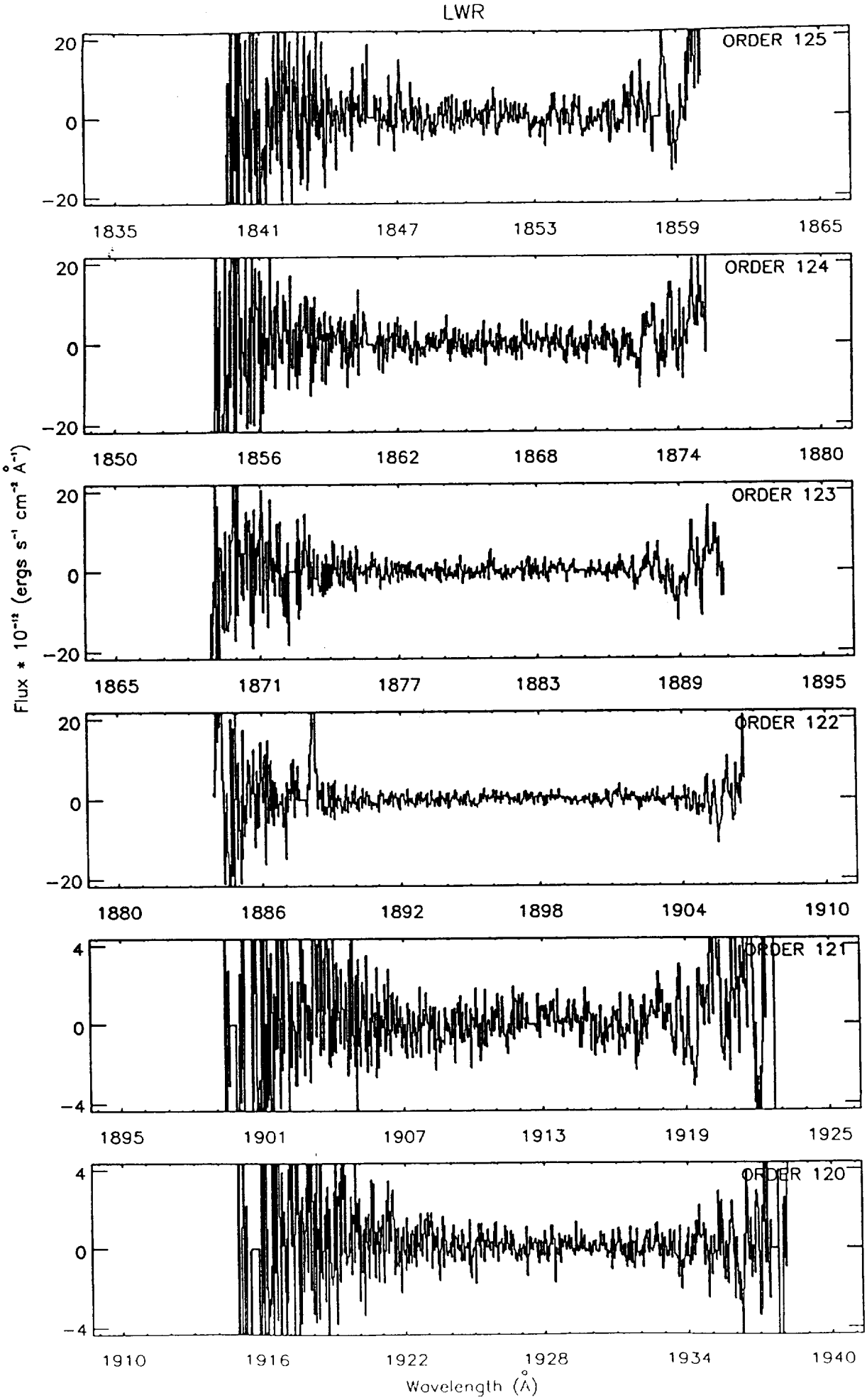

SWP
ORDER 89
ORDER 88
ORDER 87
ORDER 86
ORDER 85
ORDER 84
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)
1535
1542
1549
1556
1563
1570
1550
1558
1566
1574
1582
1590
1570
1578
1586
1594
1602
1610
1590
1598
1606
1614
1622
1630
1610
1618
1626
1634
1642
1650
1630
1636
1642
1648
1654
1660

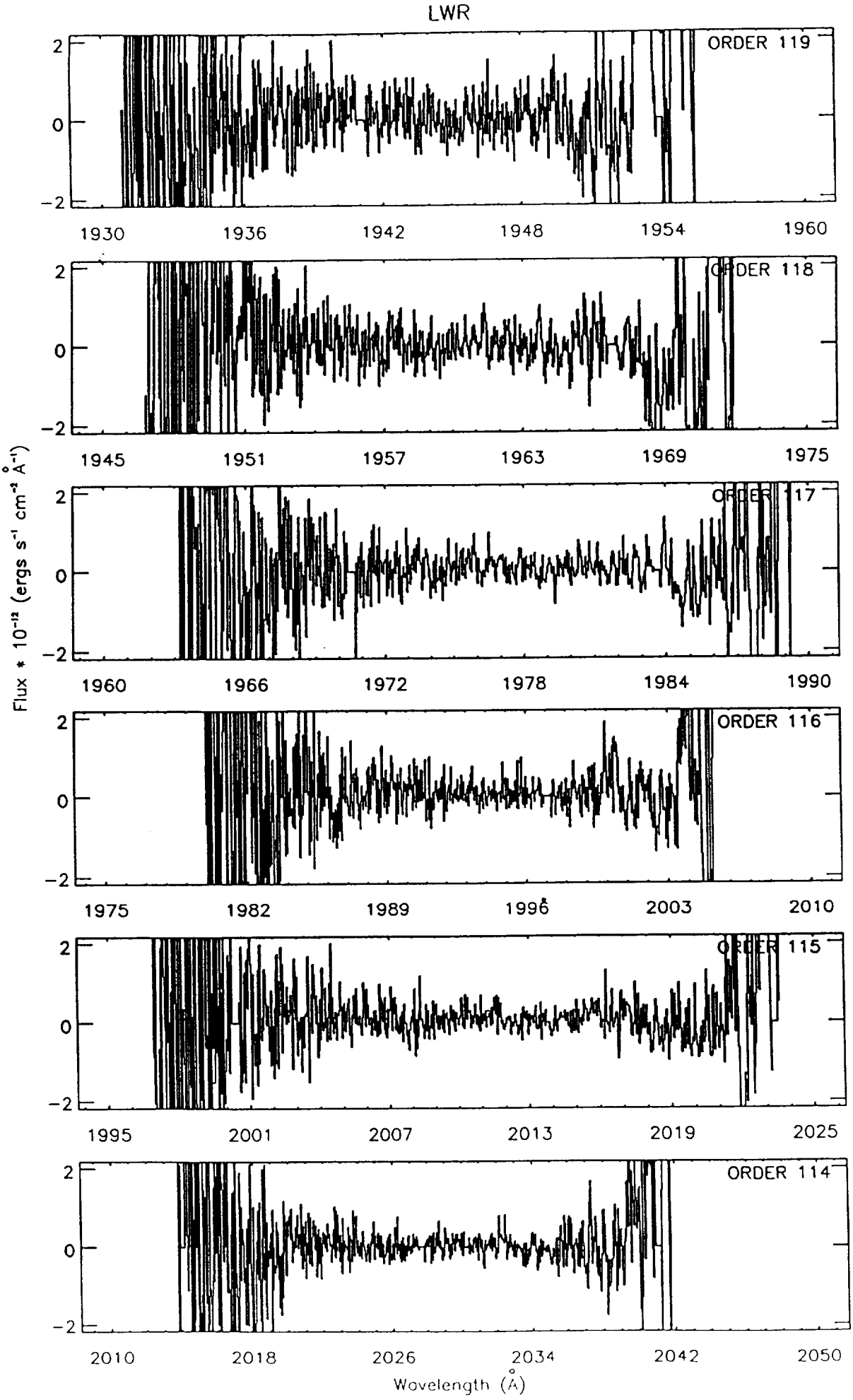

SWP
ORDER 83
ORDER 82
ORDER 81
ORDER 80
ORDER 79
ORDER 78
1
0
−1
1640
1648
1656
1664
1672
1680
1670
1676
1682
1688
1694
1700
1690
1698
1706
1714
1722
1730
1710
1718
1726
1734
1742
1750
1730
1738
1746
1754
1762
1770
1750
1758
1766
1774
1782
1790
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

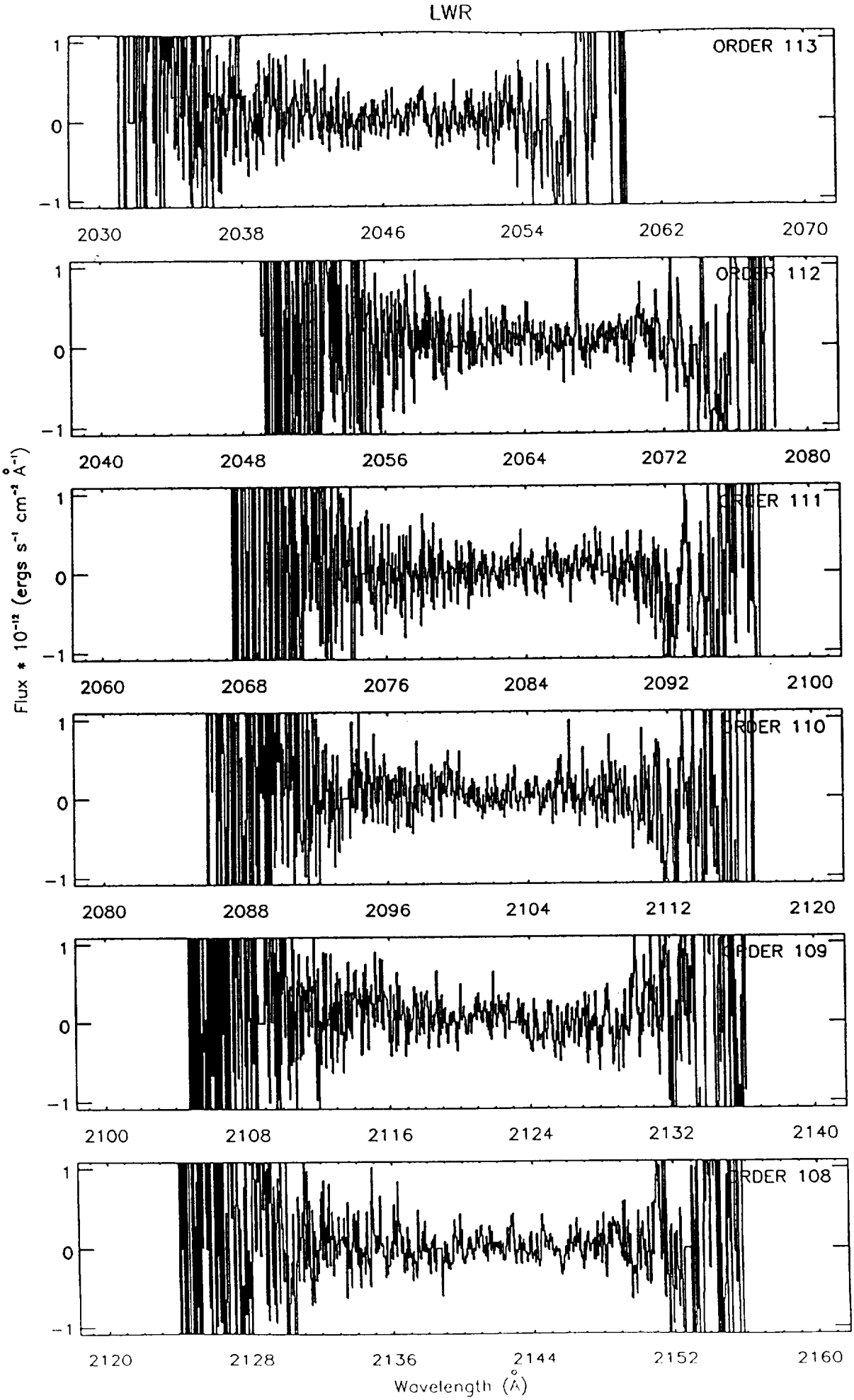

SWP
ORDER 77
ORDER 76
ORDER 75
ORDER 74
ORDER 73
ORDER 72
1.0
0.5
0.0
−0.5
1770
1778
1786
1794
1802
1810
1800
1808
1816
1824
1832
1840
1825
1832
1839
1846
1853
1860
1850
1857
1864
1871
1878
1885
1875
1882
1889
1896
1903
1910
1905
1911
1917
1923
1929
1935
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

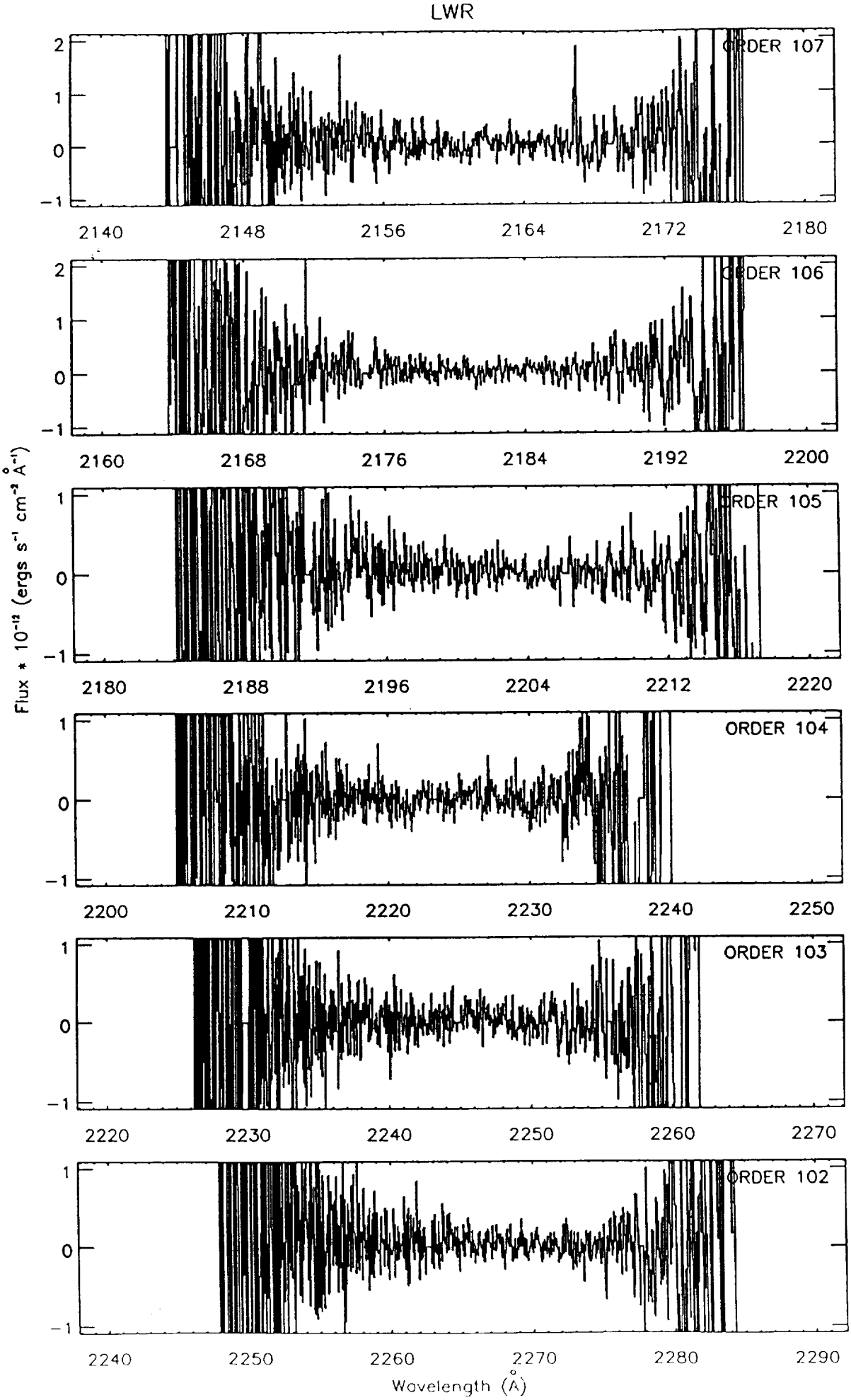

SWP
ORDER 71
ORDER 70
ORDER 69
ORDER 68
ORDER 67
ORDER 66
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

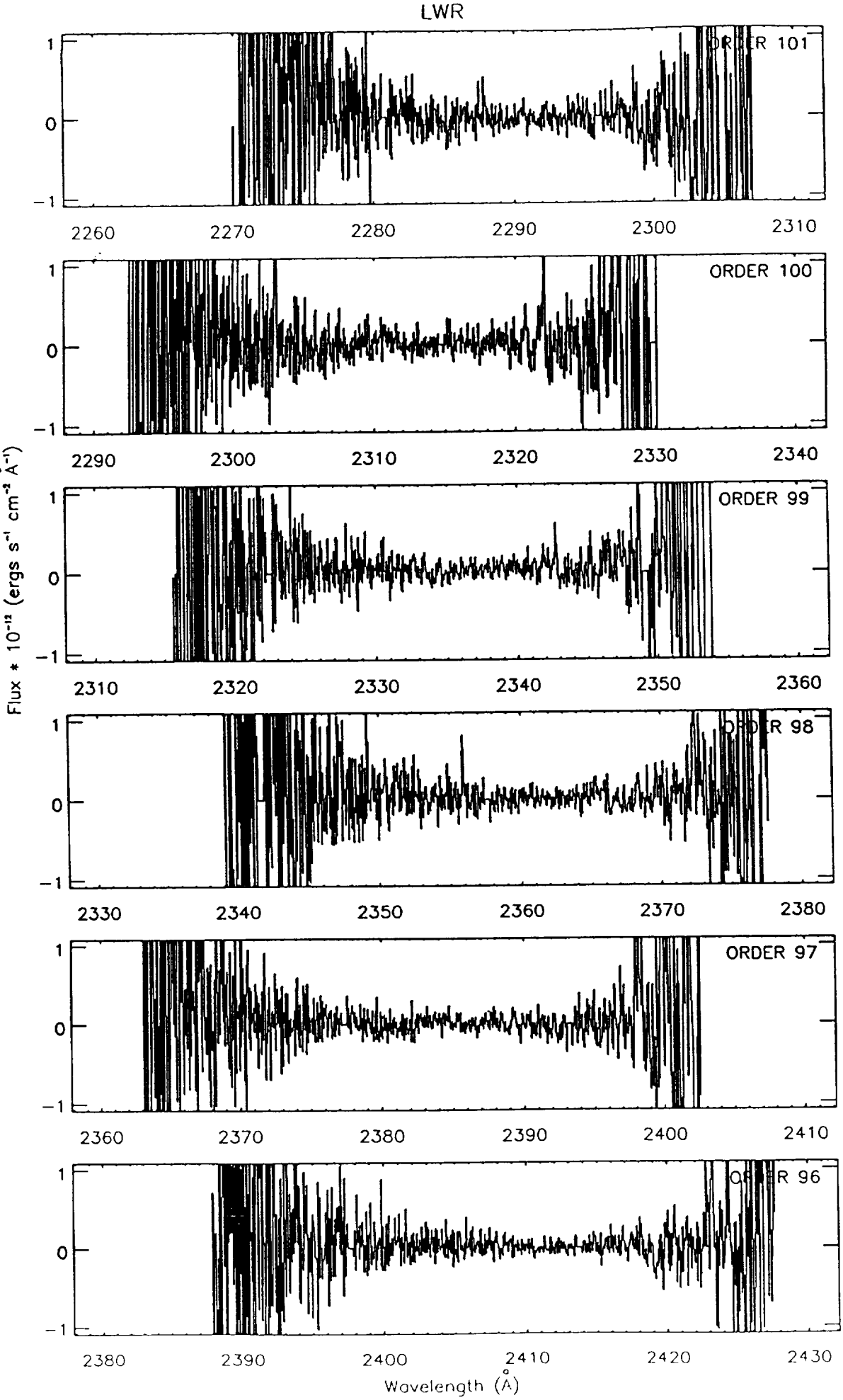
LWR

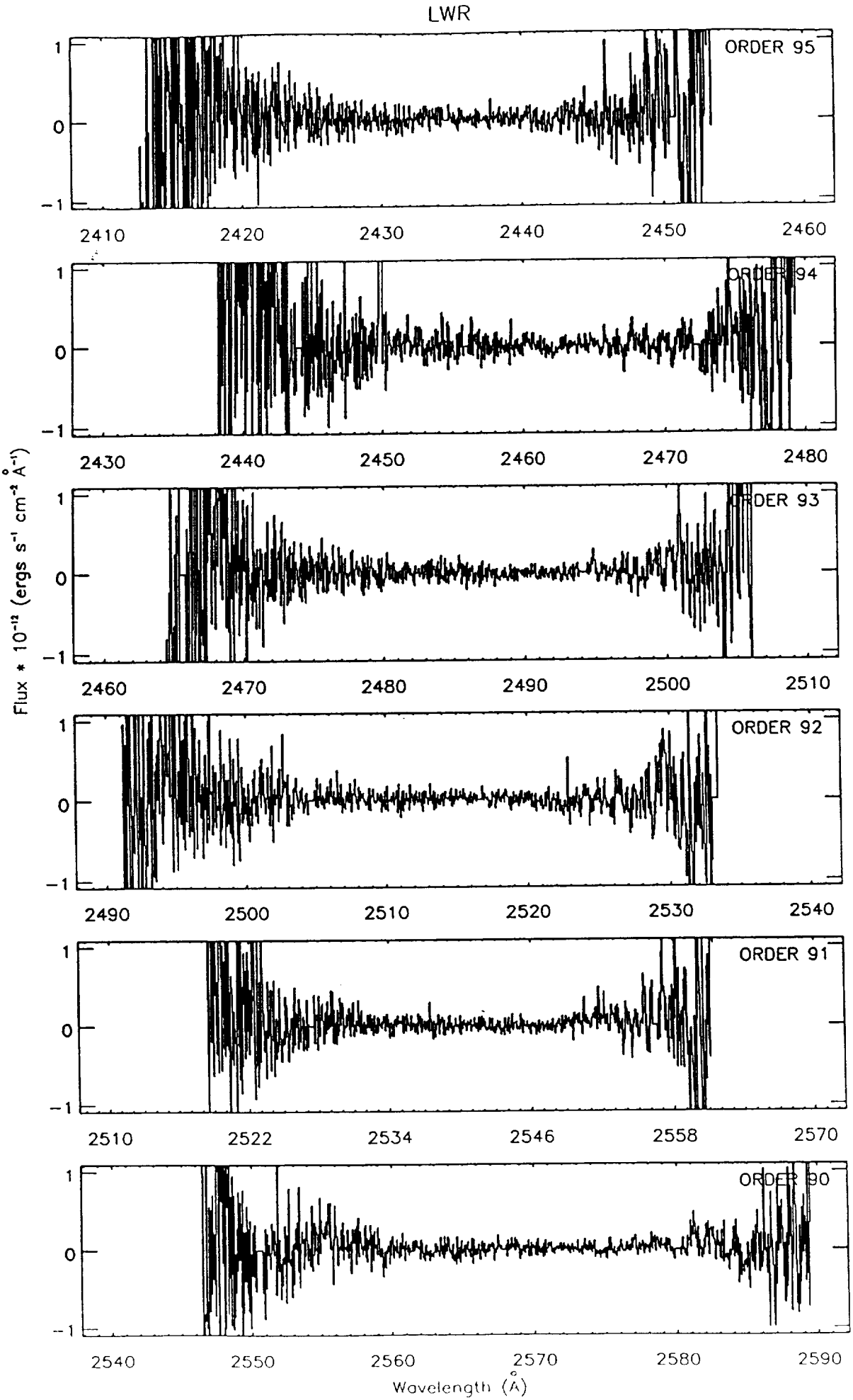

LWR
ORDER 125
ORDER 124
ORDER 123
ORDER 122
ORDER 121
ORDER 120
Flux * 10⁻¹³ (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

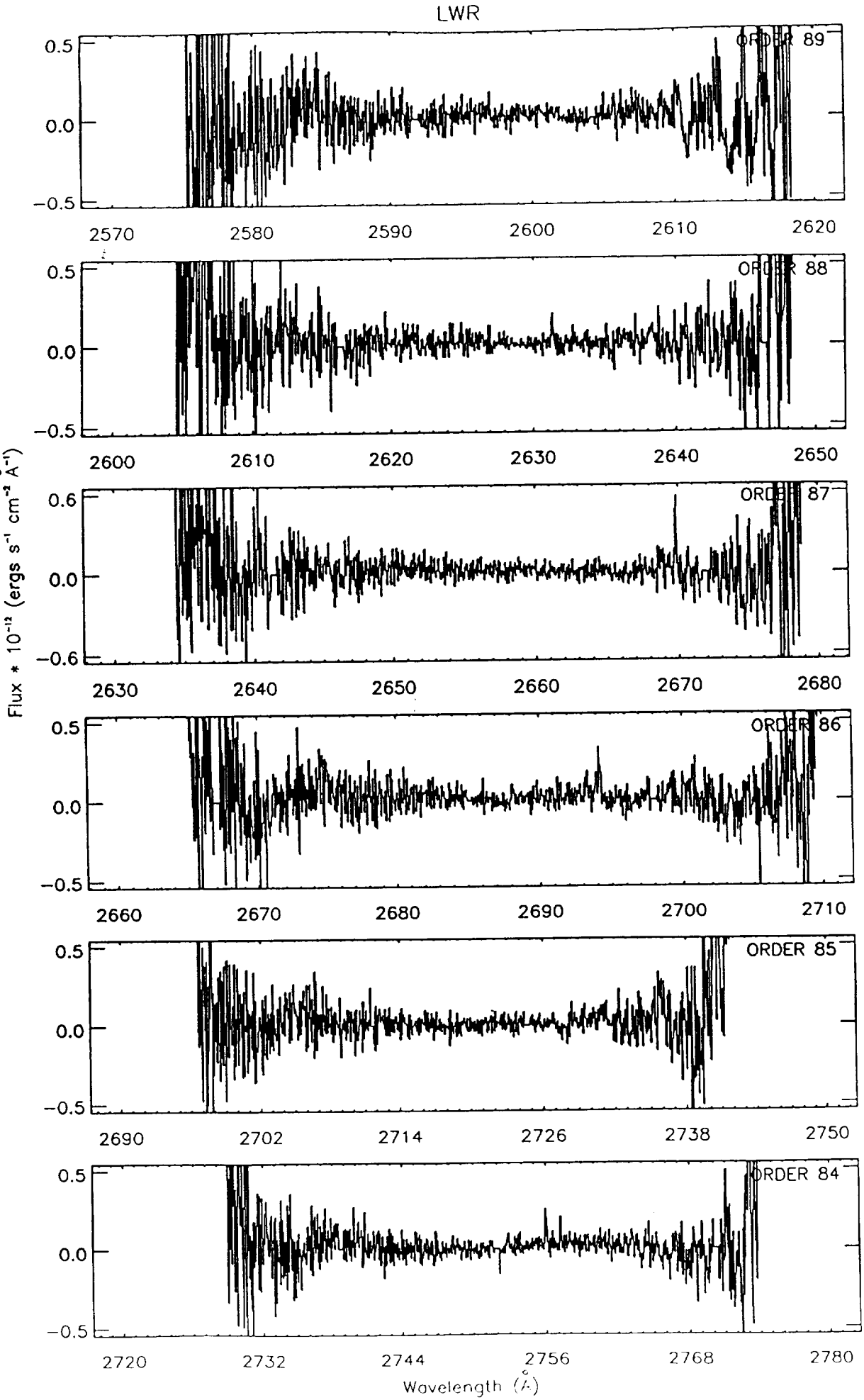

LWR
ORDER 119
ORDER 118
ORDER 117
ORDER 116
ORDER 115
ORDER 114
2
0
−2
1930
1936
1942
1948
1954
1960
1945
1951
1957
1963
1969
1975
1960
1966
1972
1978
1984
1990
1975
1982
1989
1996
2003
2010
1995
2001
2007
2013
2019
2025
2010
2018
2026
2034
2042
2050
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

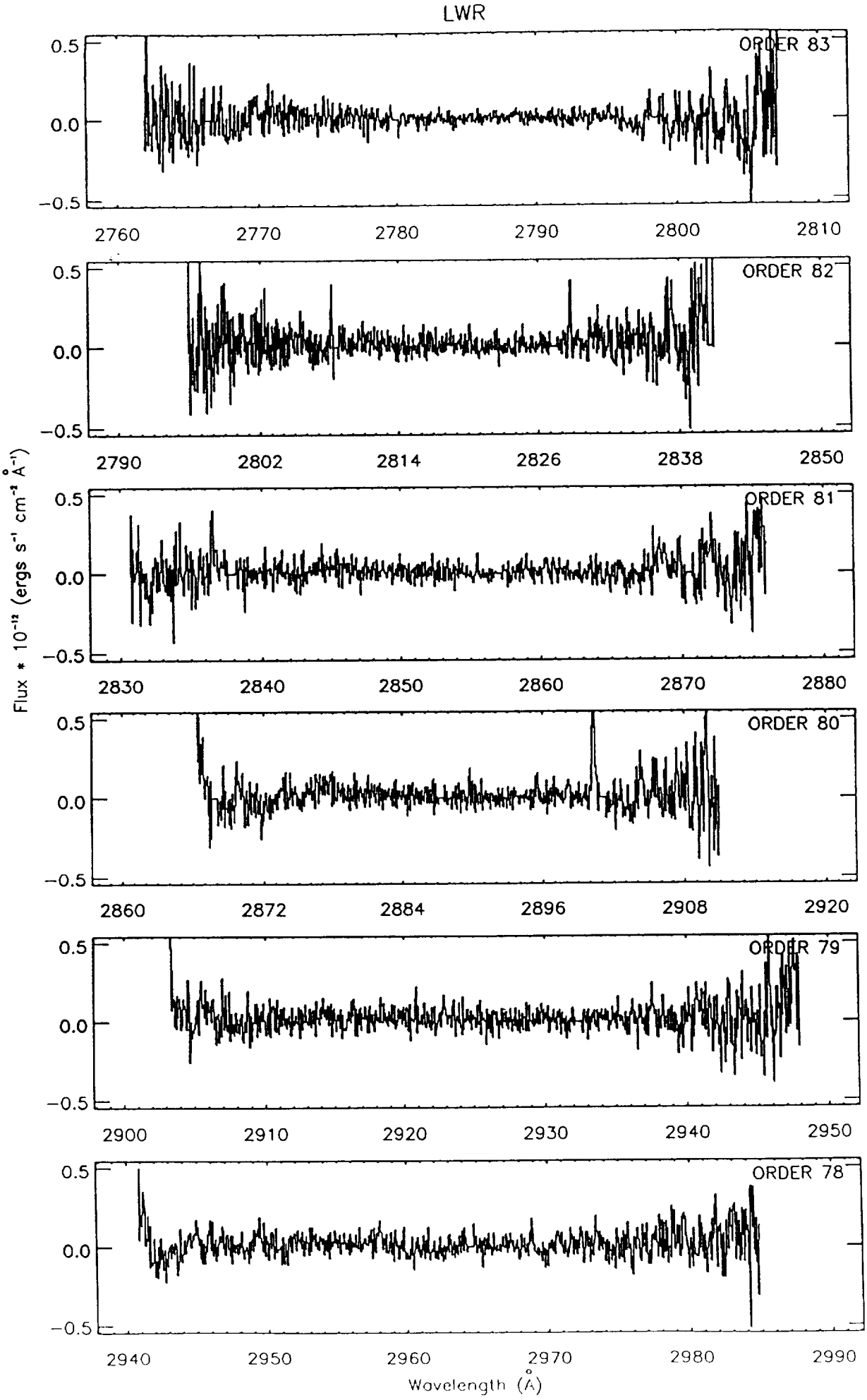

LWR
ORDER 113
ORDER 112
ORDER 111
ORDER 110
ORDER 109
ORDER 108
1
0
−1
2030
2038
2046
2054
2062
2070
2040
2048
2056
2064
2072
2080
2060
2068
2076
2084
2092
2100
2080
2088
2096
2104
2112
2120
2100
2108
2116
2124
2132
2140
2120
2128
2136
2144
2152
2160
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWR
ORDER 107
2140
2148
2156
2164
2172
2180
ORDER 106
2160
2168
2176
2184
2192
2200
ORDER 105
2180
2188
2196
2204
2212
2220
ORDER 104
2200
2210
2220
2230
2240
2250
ORDER 103
2220
2230
2240
2250
2260
2270
ORDER 102
2240
2250
2260
2270
2280
2290
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWR
ORDER 101
ORDER 100
ORDER 99
ORDER 98
ORDER 97
ORDER 96
1
0
−1
2260
2270
2280
2290
2300
2310
2290
2300
2310
2320
2330
2340
2310
2320
2330
2340
2350
2360
2330
2340
2350
2360
2370
2380
2360
2370
2380
2390
2400
2410
2380
2390
2400
2410
2420
2430
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWR
ORDER 95
ORDER 94
ORDER 93
ORDER 92
ORDER 91
ORDER 90
1
0
−1
2410
2420
2430
2440
2450
2460
2430
2440
2450
2460
2470
2480
2460
2470
2480
2490
2500
2510
2490
2500
2510
2520
2530
2540
2510
2522
2534
2546
2558
2570
2540
2550
2560
2570
2580
2590
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWR
ORDER 89
ORDER 88
ORDER 87
ORDER 86
ORDER 85
ORDER 84
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)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2910
2920
2930
2940
2950
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2950
2960
2970
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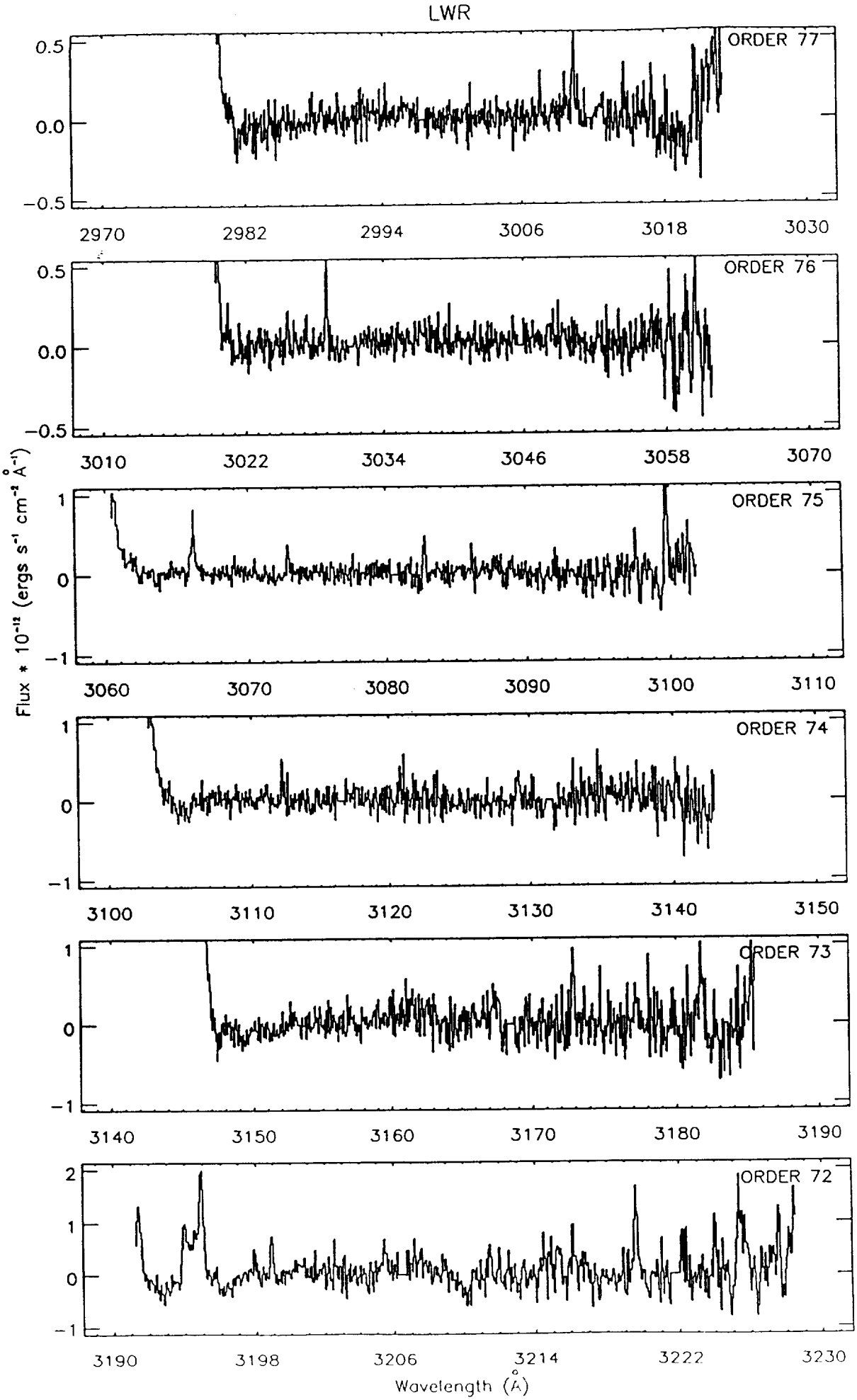
2990
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)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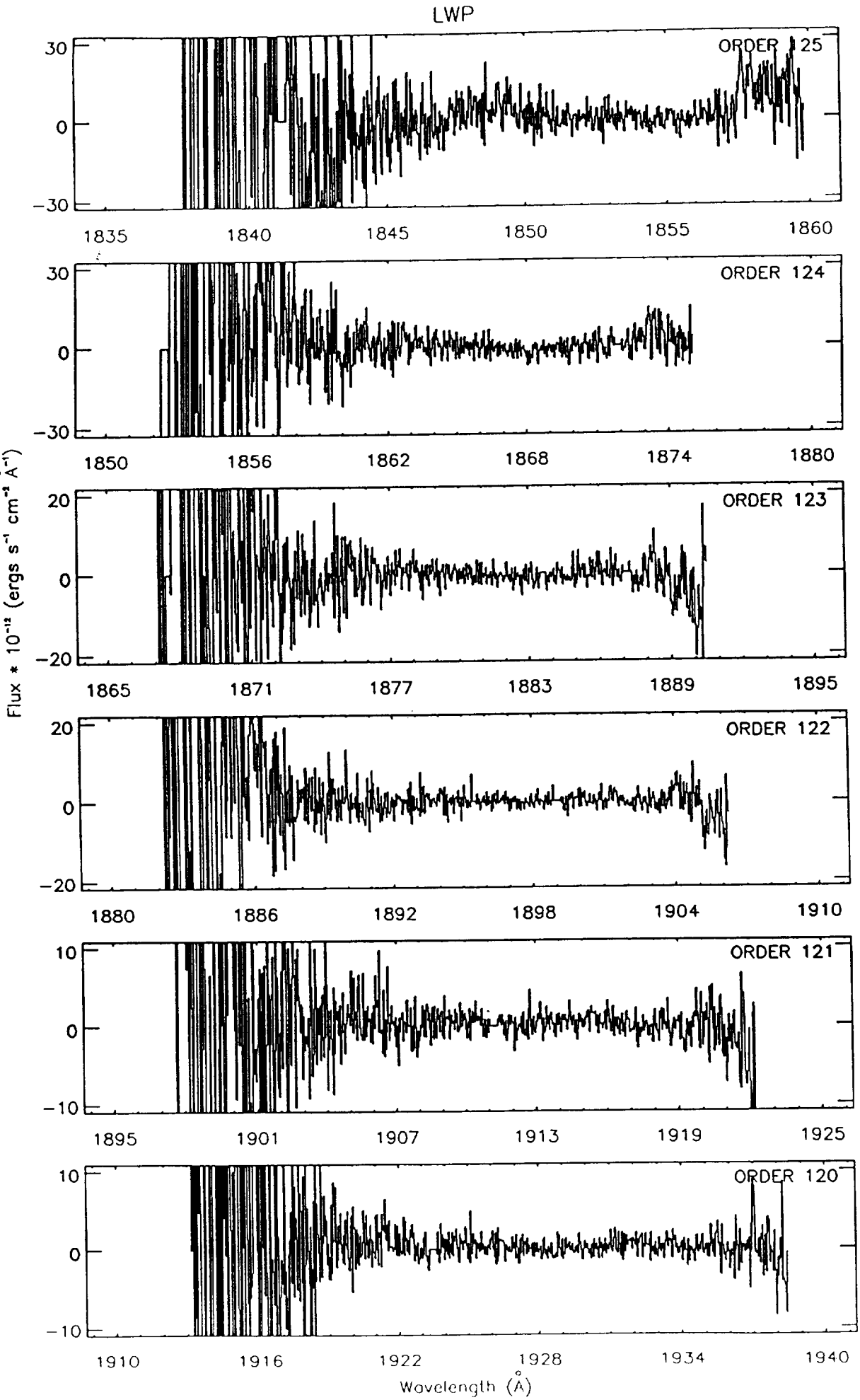
Wavelength (Å)

LWP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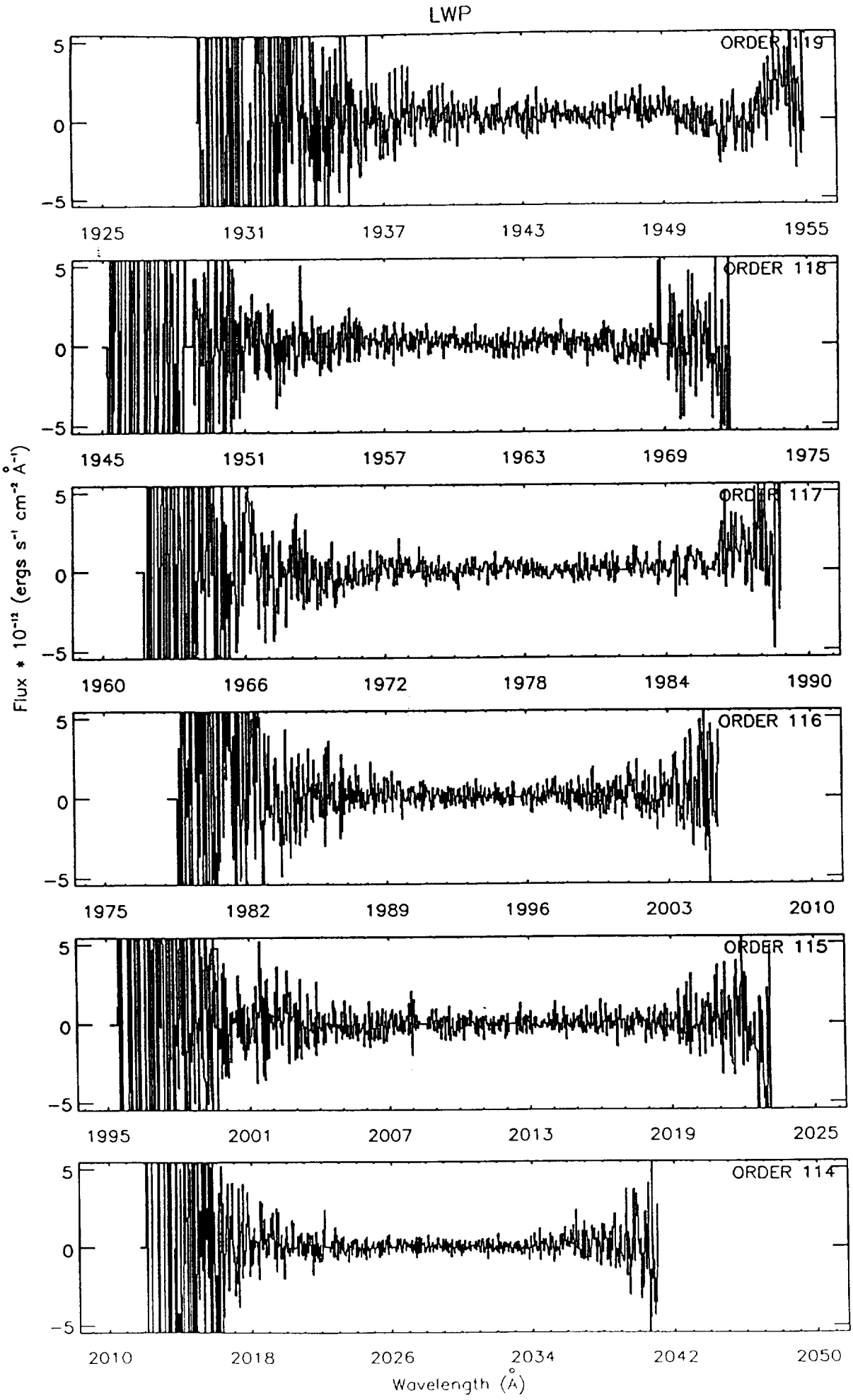
Wavelength (Å)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1984
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1975
1982
1989
1996
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2010
1995
2001
2007
2013
2019
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2010
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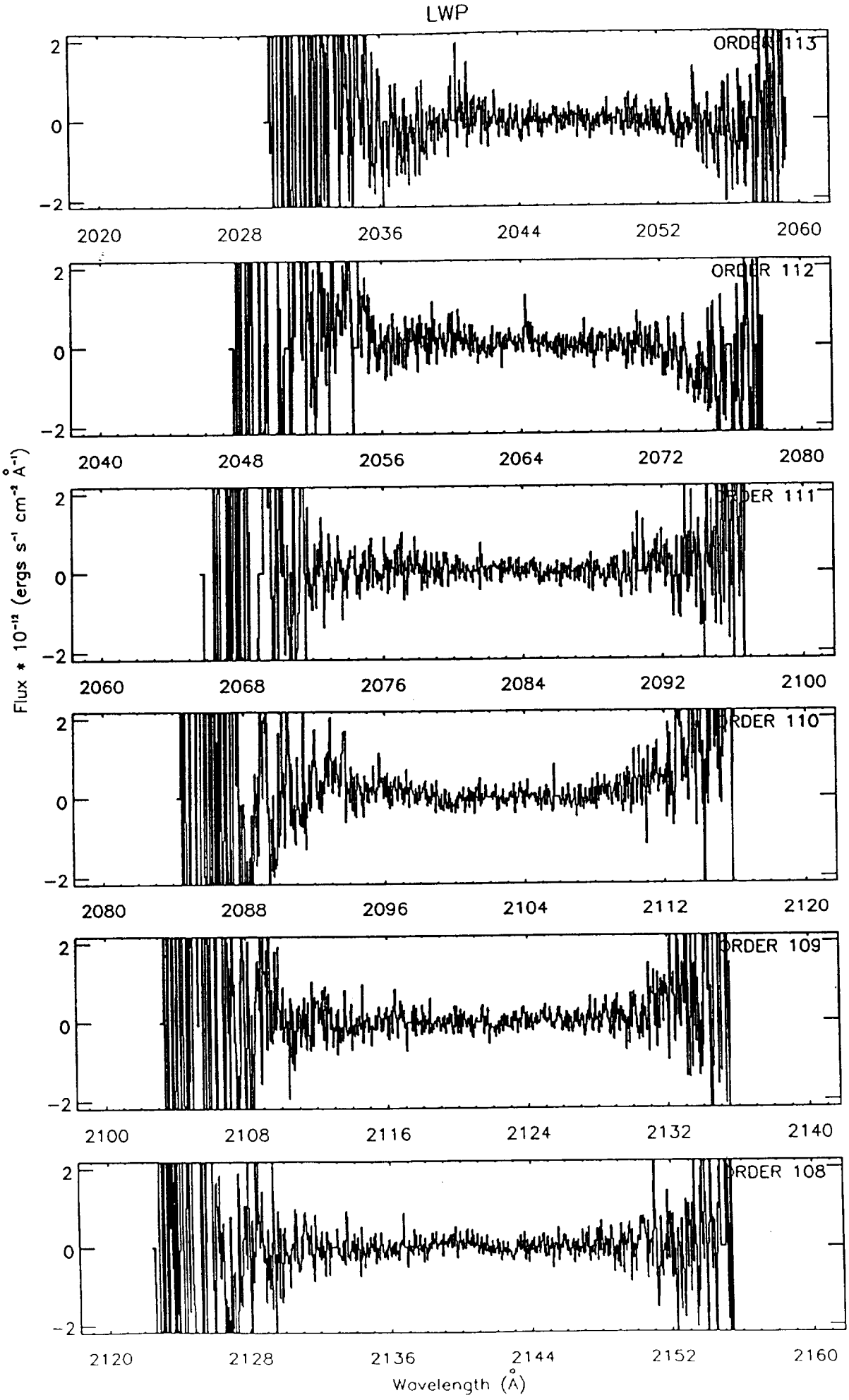
2050
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)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2104
2112
2120
2100
2108
2116
2124
2132
2140
2120
2128
2136
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2160
2
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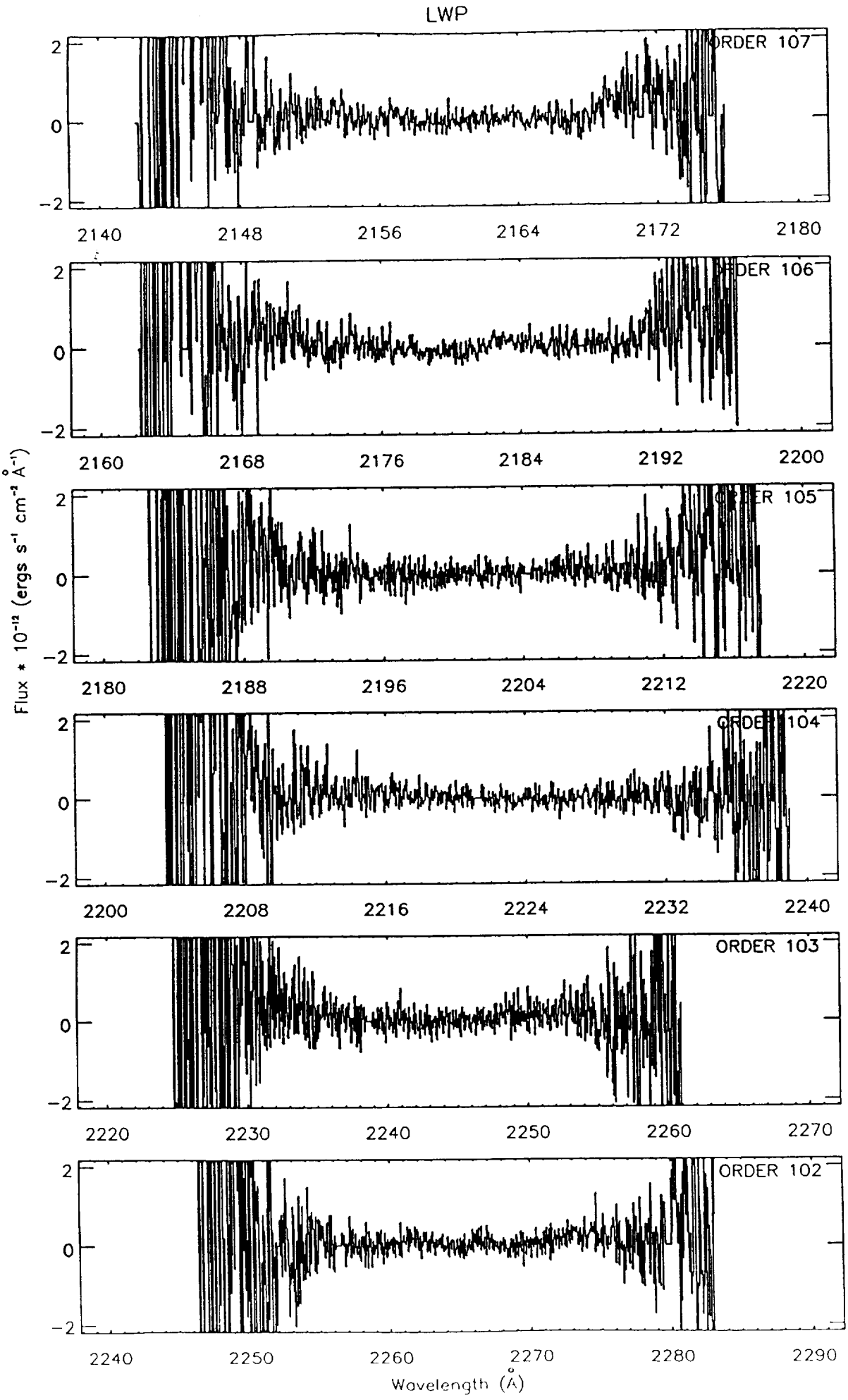
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)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2232
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2230
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2250
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2270
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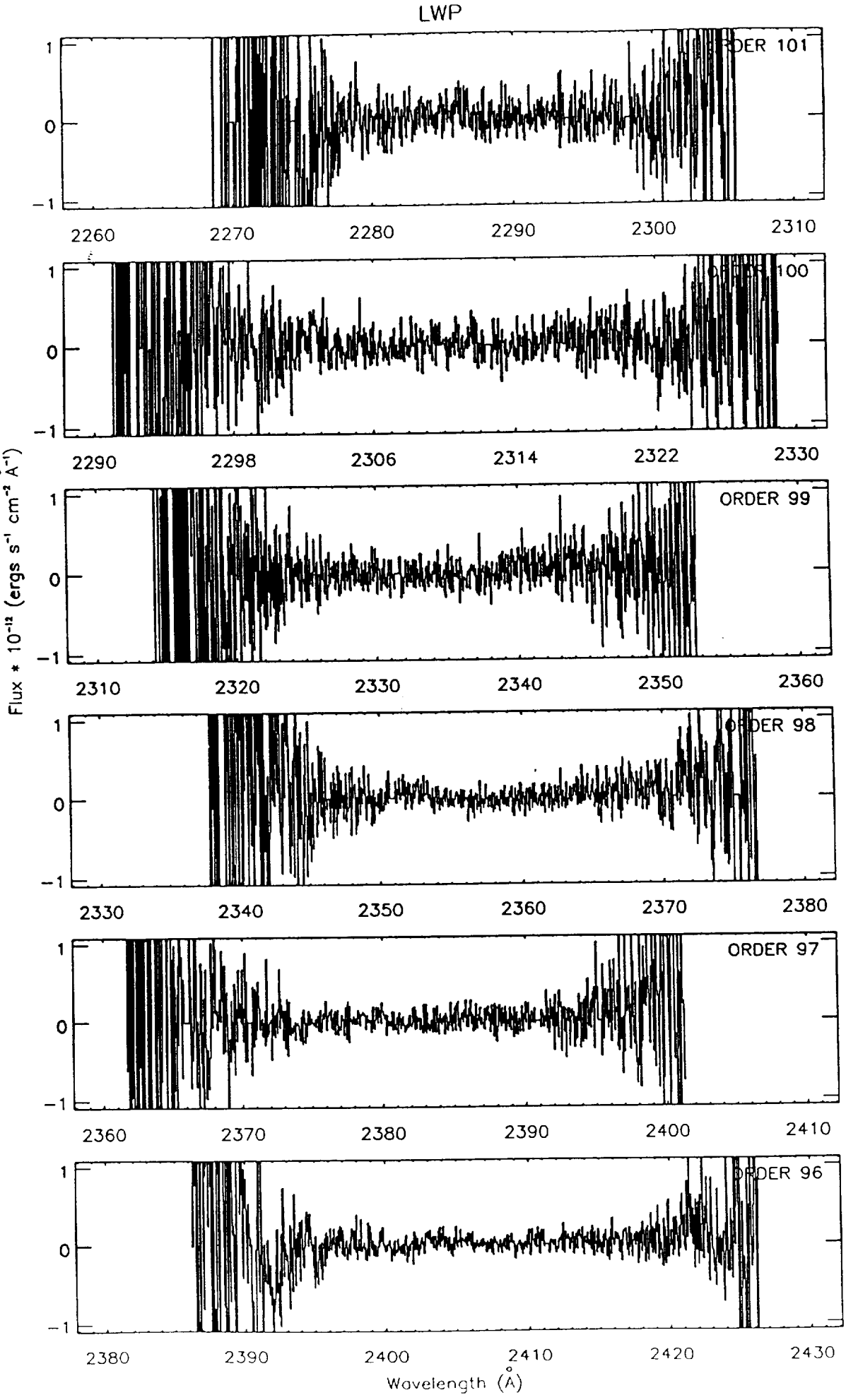
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWP
ORDER 101
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ORDER 99
ORDER 98
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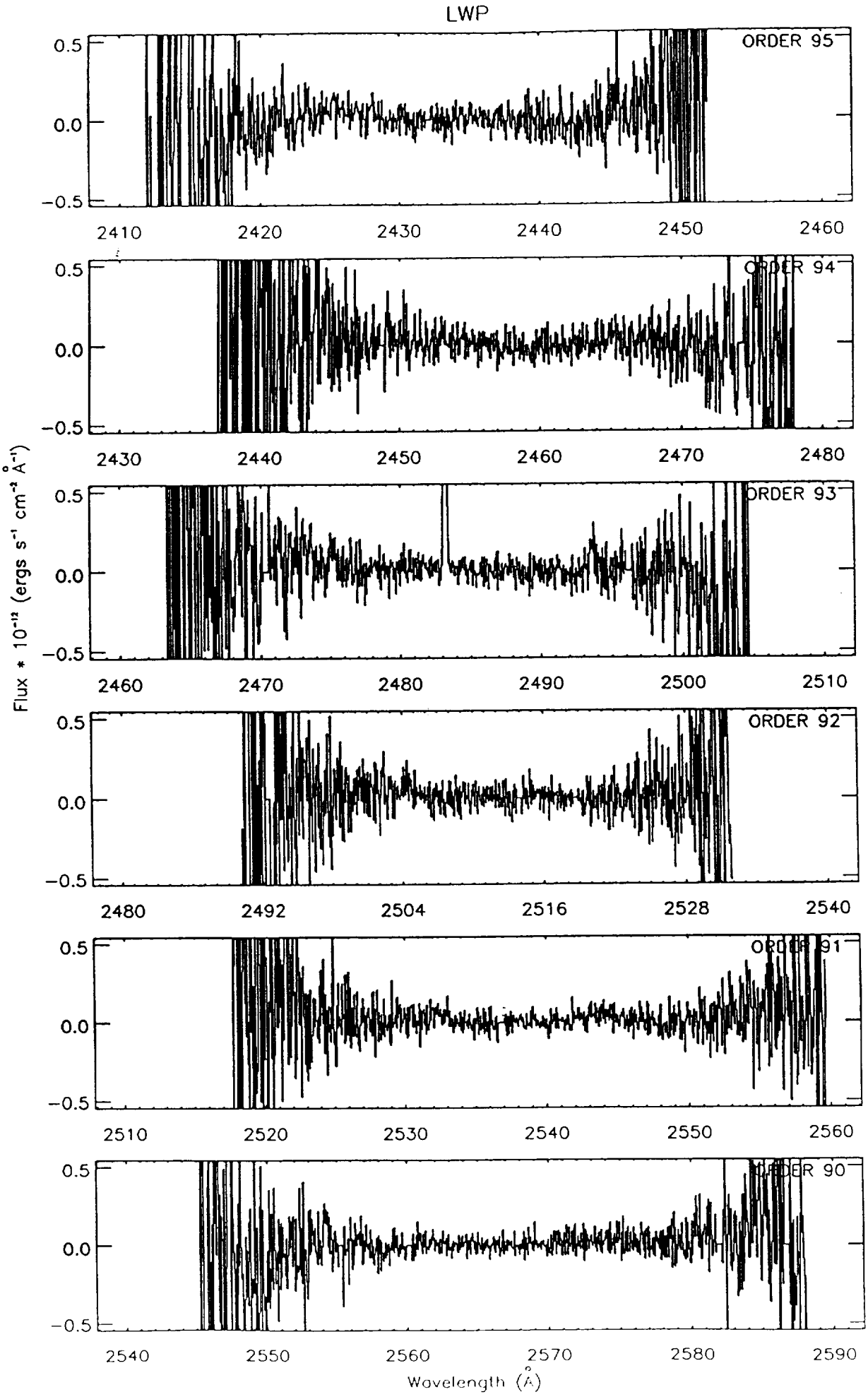
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)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ORDER 95
ORDER 94
ORDER 93
ORDER 92
ORDER 91
ORDER 90
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−0.5
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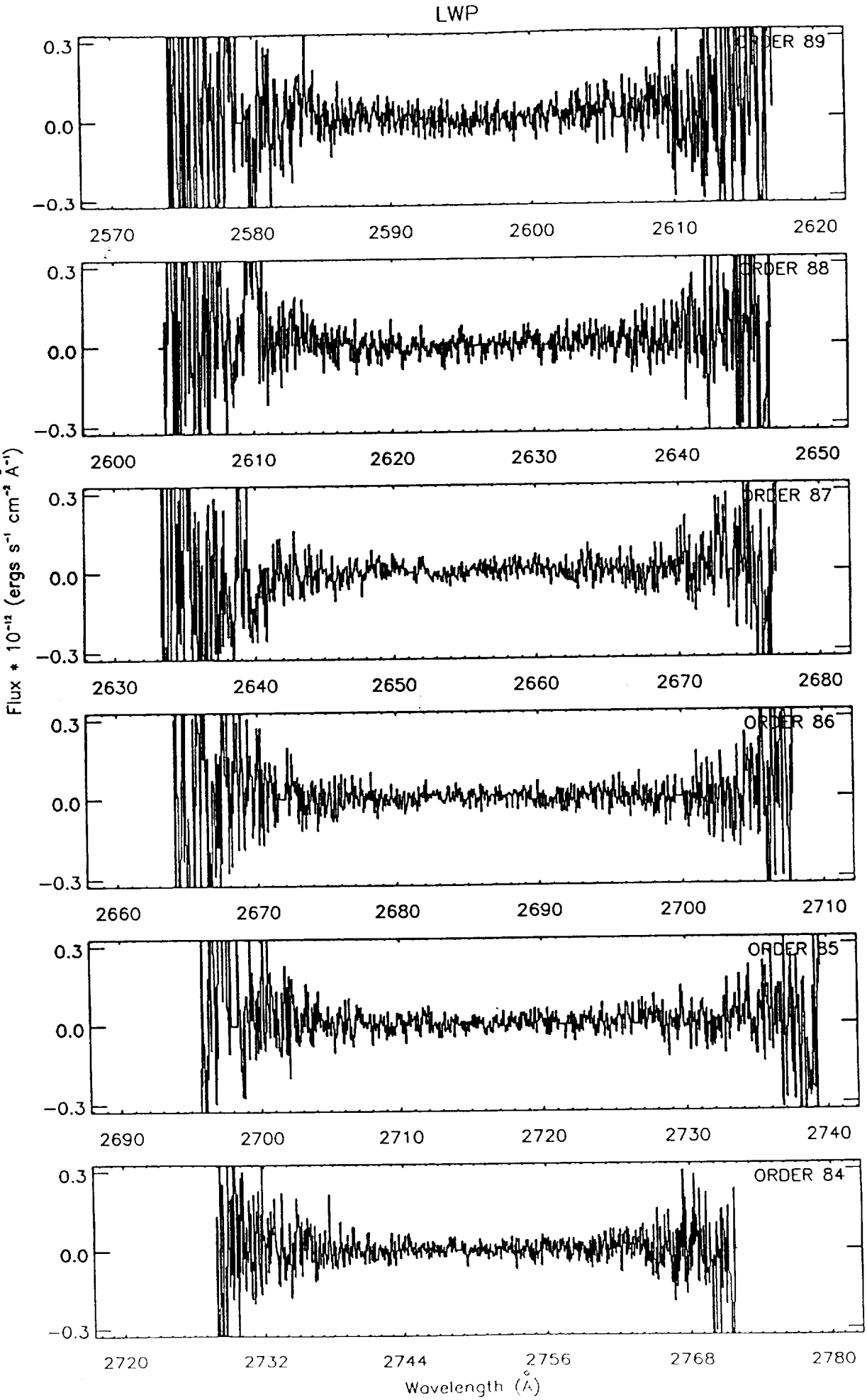
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWP
ORDER 89
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ORDER 87
ORDER 86
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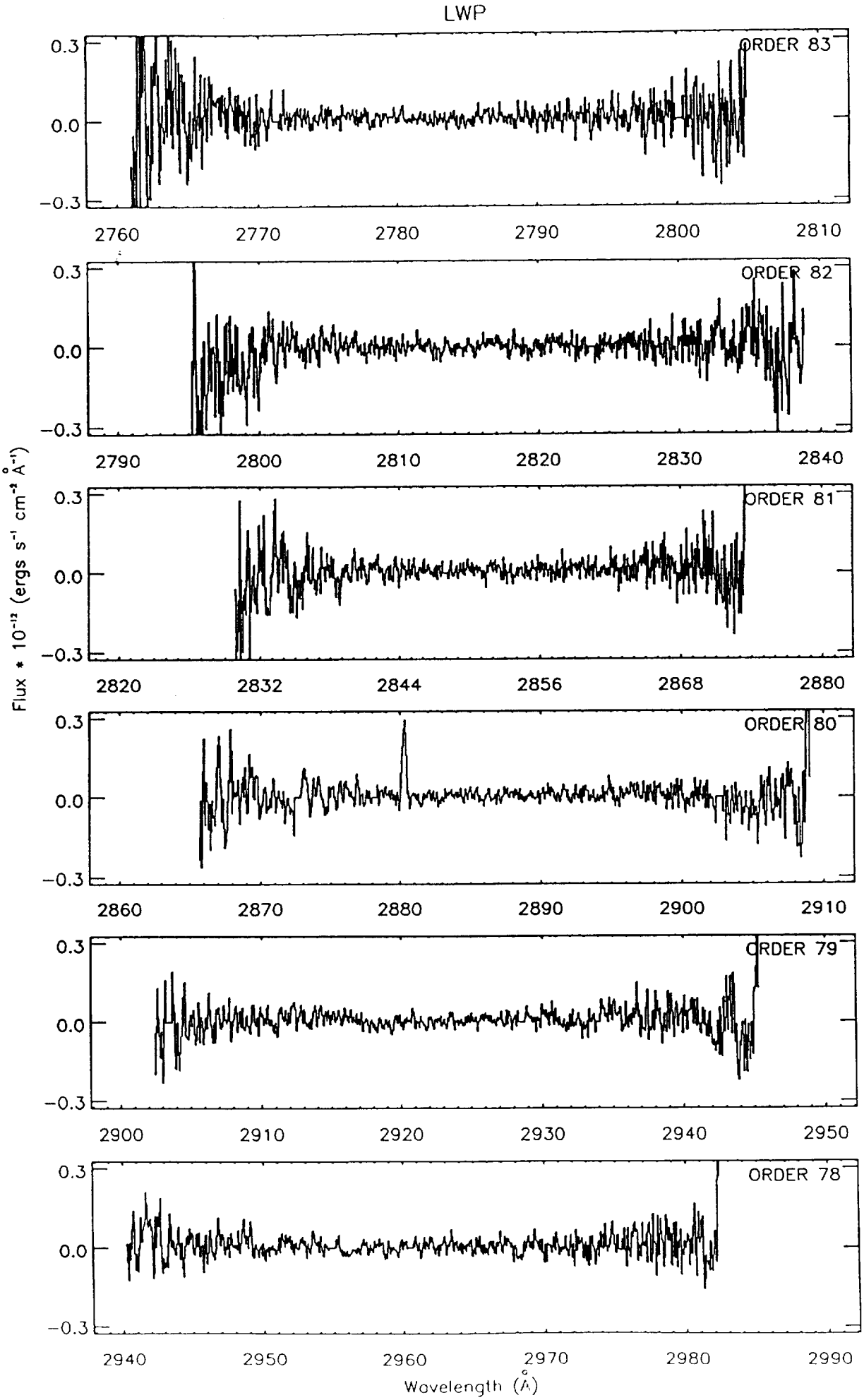
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWP
ORDER 83
ORDER 82
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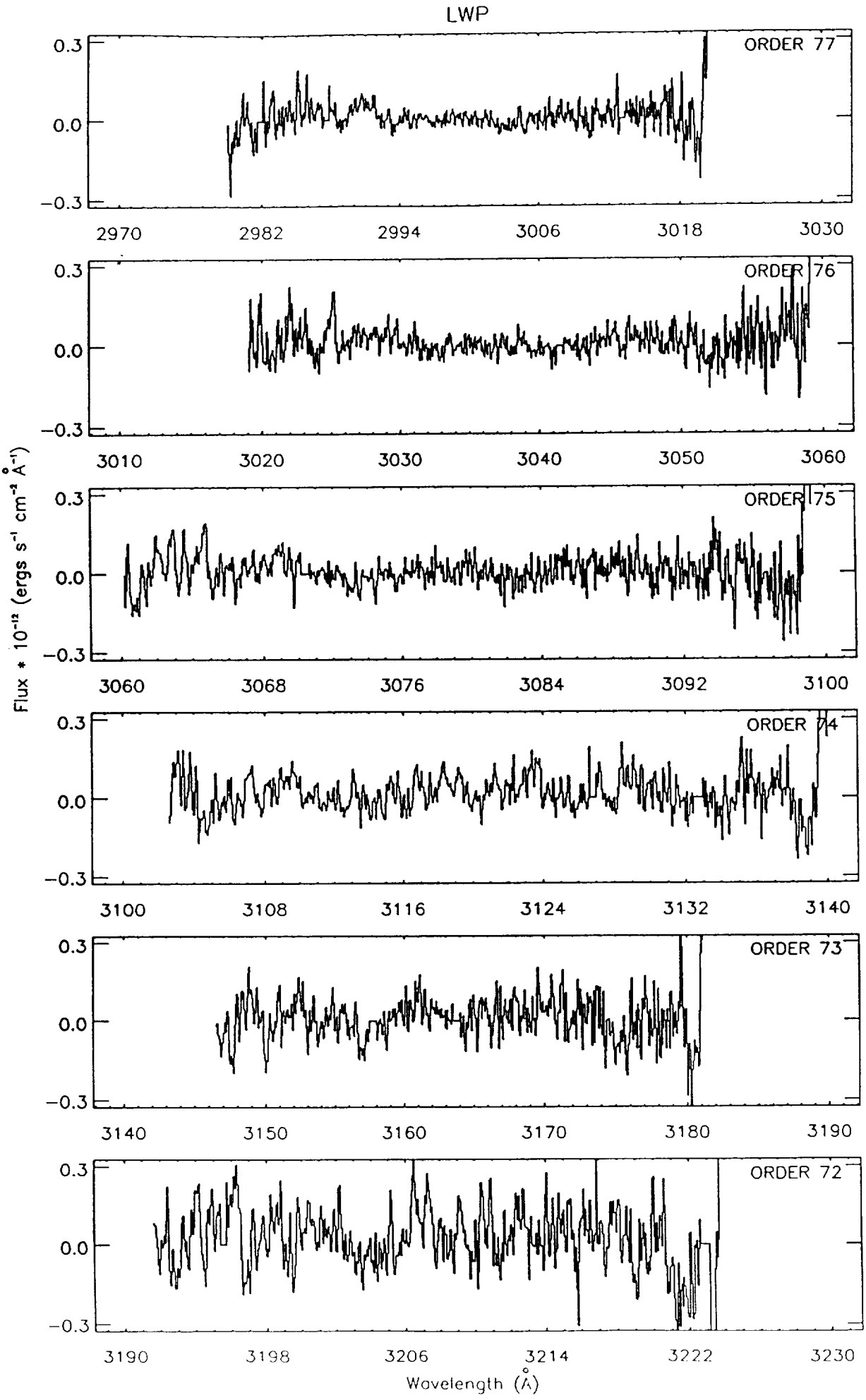
2990
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)


LWP
ORDER 77
ORDER 76
ORDER 75
ORDER 74
ORDER 73
ORDER 72
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−0.3
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2994
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3010
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3040
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3068
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3116
3124
3132
3140
3140
3150
3160
3170
3180
3190
3190
3198
3206
3214
3222
3230
Flux * 10⁻¹² (ergs s⁻¹ cm⁻² Å⁻¹)
Wavelength (Å)

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13. ABSTRACT *(Maximum 200 words)*

This study of emission line mimicking features in the IUE cameras has produced an Atlas of artifacts in high-dispersion images with an accompanying table of prominent artifacts and a table of prominent artifacts in the raw images along with a medium image of the sky background for each IUE camera.

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